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Review Article

Agronomic Management Practices for Enhancing Quality and Productivity of Fodder: A Review

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ABSTRACT

Livestock sector is an important integral part of an Indian Agriculture. The livestock population is increasing steadily year after year and creating increased pressure on available feed and fodder resources of the country. About 65-70 % of the total cost in livestock sector is incurred on the feeds only and the profitability of the sector is mainly depend on available feed and fodder resources. On the other hand, the area under fodder crops in the country is very less (8.4 million hectare), which impact on the deficit of available green fodder and dry fodder. Further there is no scope to increase the area under fodder crops due to pressure of ever increasing population on the increased food demand and nutritional security. In this regard there is a need of strategies or practices that increases the productivity and quality of fodder crops per unit area and time with effective utilization of available resources. One such important option is adoption of improved agronomic practices for increasing the productivity as well as quality of fodder.

Keywords: *Fodder, Livestock, Quality, Agronomic practices*

INTRODUCTION

Agriculture is the backbone of Indian economy but livestock is the important subsidiary enterprise in supplementation to the crop husbandry in the country. About 20.5 million peoples in the country depend upon livestock for their livelihood and this sector has an important contribution of 24.72 % to total agricultural gross domestic product (Hindoriya et al., 2019). As per the 20th livestock census, the total livestock population in the country is 535.78 million with an increase of 4.6 % over livestock census of 2012. Thus India assists 20 % of the livestock population of the world with 2.3 % of total geographical area. At present, the country faces a net deficit of 61.1 % green fodder, 21.9 % dry crop residues and 64 % concentrate feeds (Datta, 2013). At present India is having only 5.4 % (8.4 m ha) of the cultivated area under forage crops, which has resulted huge deficit of fodder.

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Hence to maintain the sustainability of the livestock sector there is a need to enhance the production and productivity of quality fodder as the feed cost alone accounts for 65-70 % of the total cost of milk production (Makkar, 2016). Surve et al. (2011) also opinioned that availability of good quality green fodder is the key to success of livestock production and without supply of quality fodder; it is difficult to sustain the health and milk productivity of the animals. But with respect to enhance the availability of quality fodder and forage, area intensification is difficult task as it faces severe competition with other commercial enterprises and food crops. Therefore, the feasible alternative remained under present context is to boost up the productivity of fodder crops per unit area and time (Hindoriya et al., 2019). The green fodder is 5-14 times cheaper source of important quality parameters like digestible crude protein and total digestible nutrients than concentrates (Agrawal et al., 2008).

In this juncture, one of the possible ways to increase the productivity of fodder crops is by adopting improved agronomic practices like optimum time of sowing, adequate seed rate and spacing, proper irrigation and nutrient management, adoption of food-fodder based cropping systems and ultimately proper time of harvesting apart from selection of high yielding genotypes. All these practices plays major role in enhancing the productivity and quality of the potential fodder crops as currently they are maintained unscientifically in the country by farmers. Patil et al. (2018) opinioned that deficit of fodder may be due to non-availability of quality seeds of improved forage varieties and lack of improved cultivation techniques for enhancing the average commercial forage and seed yields. Seed rate is one of the important factors in attaining optimum level of plant density, as it results in efficient use of resources (Ayub et al., 2002). Water and fertilizers are key inputs for sustainable crop production. Adequate and timely availability of these inputs are most important for growth and development of fodder crops in order to realize higher quality and yield (Jat & Kaushik, 2018). Jha and Tiwari (2018) opinioned that grass-legume mixtures provide a balanced diet for animals as legumes are rich in protein and non-legumes are rich in energy. Similarly Lithourgidis and Dordas (2010) also revealed that cereal + legume intercropping system helps to improve fodder yield and quality on a given land area by efficient utilization of the available resources. Hence in view of the above facts, in the present review we are discussing about the importance of agronomic cultivation practices on both qualitative as well as quantitative yield of fodder crops.

Viable agronomic practices

Adoption of improved genotypes and optimum time of sowing

Identification of suitable genotypes and optimum time of sowing along with development of location specific production technology for fodder crops offer an excellent opportunity to meet the nutritional fodder requirement for bovine population of the country (Maheswari et al., 2019). Higher fodder yield of summer fodder sorghum with better growth and yield parameters realized with cultivation of the CSV 32 F fodder sorghum variety with sowing window of first fortnight of January that possibly due to favorable climatic conditions with maximum length of growing period that prevailed during the crop growth period (Maheswari et al., 2019). On the basis of pooled data of two years, higher green fodder yield (94.2 t ha^{-1}) and dry matter yield (20.9 t ha^{-1}) was recorded in bajra Napier hybrids BNH 10 and DHN 6, respectively. Similarly significantly higher dry matter content of 22.7 per cent was also observed in DHN 6. However, higher crude protein content (8.7 %) and crude protein yield (1.64 t ha^{-1}) was recorded in APBN 1 hybrid (Singh et al., 2018). Similar kind of results was noticed with respect to higher green fodder yield, dry matter yield, crude protein yield and leaf-stem ratio in BNH-10 genotype by Shashikanth et al. (2013) compared to other genotypes of bajra Napier hybrid. Singh and Garg (2015) revealed that Anand lucerne-3 variety recorded higher green fodder (65.27 t ha^{-1}), dry matter (16.36 t ha^{-1}) and crude protein (2.97 t/ha) yields in comparison to T-9 and Alamdar-1 varieties and opinioned as best variety for green fodder production in north-western parts of country specifically in Gujarat. The temperature also plays an important role in achieving higher productivity of fodder particularly in case of rabi fodder crops like oats, lucerne, berseem *etc*. In this regard Kumar and Patel (2013) studied the influence of optimum time of sowing in lucerne and obtained significantly higher green fodder yield (343.78 q ha^{-1}) and dry matter yield (64.14 q ha^{-1}) when crop was sown on 10th November than rest of the sowing dates.

Seed rate and spacing

Generally higher plant densities are favorable for higher production in forage crops than grain crops however, forage crops also have certain maximum limit of increase in plant population. Forage crops respond in a different way to plant densities under different cultural practices and environmental conditions which greatly influence the forage yield and quality. Subrahmanya et al. (2019) recorded higher plant height (246.73), number of leaves (15.01), green fodder yield (559.49 q ha^{-1}) and dry matter yield (125.08 q ha^{-1}) of fodder maize with 90 kg ha^{-1} seed rate and found on par with 75 and 60 kg ha^{-1} seed rate, which clearly indicating that optimum seed rate is desirable for fodder production in a most economic way. Similarly in case of multi cut fodder sorghum (CoFS-29) seed rate of 7.5 kg ha^{-1} recorded significantly higher green fodder and dry fodder yield (79.88 and 18.51 t ha^{-1}, respectively) as compared to seed rate of 5 kg ha^{-1} (67.99 and 14.09 t ha^{-1}, respectively) but found on par with 10 kg ha^{-1} seed rate (76.51 and 17.40 t ha^{-1}) (Somashekar et al., 2015). While with respect to sweet sorghum, seed rate of 40 kg ha^{-1} recorded significantly higher green fodder yield (42.82 t ha^{-1}), dry matter yield (6.18 t ha^{-1}), crude protein yield (0.54 t ha^{-1}) and crude fiber yield (1.90 t ha^{-1}) compared to 30 and 50 kg ha^{-1} seed rate (Nabooji et al., 2018).

Significantly higher crude protein and ash content of fodder maize with 30 cm x 20 cm plant spacing was reported by Bharti et al. (2019). However crude fiber content was highest with spacing of 45 cm x 20 cm but it was at par with 50 cm X 15 cm spacing. Similarly in sweet sorghum, Chattha et al. (2017) recorded significantly higher fresh forage yield (38.1 t ha^{-1}) and dry matter yield (4.85 t ha^{-1}) in line sowing at 30 cm compared to sowing of seeds through broadcasting and line sowing at 45 cm apart. However, they also observed considerably higher crude protein, crude fibre, ash and sugar per cent with line sowing of seeds at 30 cm distance.

Irrigation management

Water is the basic input for increasing green fodder production and agricultural productivity can't be maintained without assured supply of moisture to the plant which is accomplished by irrigation. Application of five irrigations during crop period of oat resulted in significantly higher yield of crude protein (1965.59 kg ha^{-1}), crude fibre (5271.72 kg ha^{-1}), ether extract (308.28 kg ha^{-1}), mineral matter (1290.18 kg ha^{-1}), nitrogen free extract (8759 kg ha^{-1}) and total digestible nutrient (12688.15 kg ha^{-1}) with a magnitude of 29.50, 27.09, 30.38, 26.92, 15.54 and 20.83 per cent respectively, over two irrigations but it was found statistically on par with application of four irrigations (Jat & Kaushik, 2018). The results of Pareek et al. (2015) revealed that frequent application of irrigation at IW/CPE ratio of 1.0 significantly increased the plant height, tillers per meter row length and leaf to stem ratio thus subsequently produced higher green forage, dry matter and crude protein yields of pearlmillet. In bajra Napier hybrid grass large number of feeder roots can be observed on the top layer of soil. In this regard Vennila and Ananthi (2019) studied the influence of drip irrigation with different irrigation levels and the results revealed that drip irrigation at 100 % potential evaporation (PE) resulted in higher biomass yield (259.17 t ha^{-1} and 296.78 t ha^{-1}) and leaf stem ratio (0.72 and 0.76) during 2014 and 2015, respectively compared to drip irrigation at 75% PE and surface irrigation. In case of lucerne, maximum green forage yield of 26.80 t ha^{-1}

and crude protein percentage of 21.05 was obtained when crop was irrigated at 20 days interval (Ehsas et al., 2018).

Nutrient management

Fertilizer application particularly at critical growth stages is one of the principle factors that directly influence the fodder yield and quality. Fertilization is most important agronomic practice that supplies essential nutrients such as nitrogen, phosphorus, potassium and other micronutrients as well as macronutrients, which plays an important role in plant growth, yield and quality (Subrahmanya et al., 2019). Jat and Kaushik (2018) revealed that application of 90 kg nitrogen ha^{-1} resulted in 15.89, 9.99, 14.99, 14.45, 10.87 and 11.23 per cent higher crude protein, crude fibre, ether extract, mineral matter, nitrogen free extract and total digestible nutrient of oat, respectively over 70 kg nitrogen ha^{-1}. Significantly higher plant height (280.92 cm), leaf length (118.10 cm), leaf width (9.11 cm), number of leaves (17.13), green fodder yield (637 q ha^{-1}) and dry matter yield (140.98 q ha^{-1}) of fodder maize was observed with 125 % recommended dose of fertilizers followed by 100 % recommended dose of fertilizers when compared to other level of fertilizers (Subrahmanya et al., 2019). Similar kind of higher green fodder yield (45.85 t ha^{-1}), dry matter yield (6.64 t ha^{-1}), crude protein yield (0.63 t ha^{-1}) and crude fibre yield (1.91 t ha^{-1}) were noticed with application of 125 % of recommended dose of fertilizers in sweet sorghum by Nabooji et al. (2018). In case of multi cut fodder sorghum (CoFS-29) application of 60 kg nitrogen ha^{-1} recorded significantly higher green fodder and dry matter yield of 80.26 and 18.23 t ha^{-1}, respectively as compared to 15 kg nitrogen ha^{-1} (65.19 and 13.80 t ha^{-1}, respectively) but it was found at par with 45 and 30 kg nitrogen ha^{-1} (Somashekar et al., 2015). The application of 75% nitrogen + Rhizobium inoculation recorded higher green (25.02 t ha^{-1}) and dry fodder yield (4.29 t ha^{-1}) over control and 75 % nitrogen application alone. They also observed successive increase of nitrogen levels did not influence fodder yield of cowpea. However with respect to quality parameters like dry matter, crude protein, ether extract, total ash, total carbohydrates and cell contents, application of 100 % nitrogen + Rhizobium inoculation performed better compared to other nitrogen levels (Mallikarjun et al., 2018).

In case of maize + cowpea intercropping, Tamta et al. (2019) observed higher dry matter yield of the system (143.64 q ha^{-1}) with enhanced level of nitrogen from 0 to 120 kg ha^{-1} and the magnitude of increase was 46.51, 9.44, 5.00 and 1.79 per cent over 0, 30, 60 and 90 kg nitrogen ha^{-1}, respectively. These results of higher dry matter yield with enhanced level of nitrogen were also in close agreement with the outcomes of Ayub et al. (2002) and Tripathi and Hazra (2002). Similarly, higher green fodder (544.4 q ha^{-1}), dry matter (127.7 q ha^{-1}) and crude protein yields (11.5 q ha^{-1}) under Jowar + Cowpea system with 100 % recommended dose of inorganic fertilizers was also reported by Jha et al. (2018).

Adoption of cropping systems

To meet the green fodder requirement of animals, cultivation of annual and perennial grasses in food-forage based cropping systems have become popular among dairy farmers in India as they provide year round supply of fodder to bovine population of the country (Dwivedi et al., 2007). In most cases the nutritional quality of cereal fodder is lower as compared to legume. The nutritional quality of cereal fodder or grasses can be enhanced either by mixing legume or growing of legume as inter/mix crop in field condition itself (Halli et al., 2018). Crop mixtures involving legumes and non-legumes provide a balanced diet for animals as legumes are rich in protein and non-legumes are rich in energy (Jha and Tiwari, 2018). Addition of fodder legumes with fodder cereals can improve fodder quality of mixture and reduce the fiber content (Njoka-Njiru et al., 2006). The maximum green fodder (637.5 q ha^{-1}), dry fodder (119.5 q ha^{-1}) and crude protein yields (14.46 q ha^{-1}) were recorded with Napier bajra hybrid intercropped with cowpea than sole Napier bajra hybrid and the magnitude of increase was 5.04, 2.31 and 26.05 %, respectively (Hindoriya et al., 2019). Similarly in case of maize + cowpea intercropping Tamta et al. (2019) obtained higher dry matter yield (141.22 q ha^{-1}) under 2:1 ratio followed by 1:1 ratio (127.25 q ha^{-1}) while minimum was observed under 1:2 ratio. Prajapati et al. (2018) also revealed that association of cowpea with maize led to higher crude protein and digestible dry matter content in fodder while, dry matter intake, total digestible nutrients, cell content, relative feed value and net energy was significantly higher under sweet sorghum + cowpea compared to other intercropping systems.

Patil et al. (2018) studied different year round forage crop modules and obtained significantly higher green fodder yield (1701.41 q ha^{-1} $year^{-1}$) in hybrid Napier + desmanthus (1:5) system followed by hybrid Napier + lucerne (1:5) throughout the year (1415.59 q ha^{-1} $year^{-1}$) when compared to other modules. Similar kind of higher green and dry fodder yields were also reported by Chandrika et al. (2012) with Napier bajra hybrid + cowpea – lucerne cropping system. Jha and Tiwari (2018) reported that adoption of maize + rice bean (2:1) – oat multi cut - sorghum multi cut + cowpea (2:1) cropping system provided significantly higher green fodder yield (1180 q ha^{-1}) and dry fodder yield (247 q ha^{-1}) while multi cut pearlmillet + rice bean (2:1) – berseem – maize + cowpea (2:1) cropping system recorded significantly higher crude protein yield (25.84 q ha^{-1}) compared to other cropping systems.

Integration of forages in food based production systems may prove sustainable and economically viable, which not only provide food but also supports live stock by supplying green fodder (Chandrika et al., 2012). Higher pigeon pea yield equivalent (15.76 q ha^{-1}) was realized by Kumar et al. (2018) when fodder cowpea was intercropped with pigeon pea and the magnitude of increase was 64 % than sole pigeon pea. They also revealed that intercropped sorghum produced more green fodder yield (174.45 q ha^{-1}) and dry fodder yield (37.145 q ha^{-1}) compared to other fodder crops taken as an intercrop with pigeon pea.

Time of harvesting

The time of harvesting and cutting frequency are important agronomic practices for multicut forage crops like Napier, sorghum, pearlmillet, lucerne, hedge lucerne *etc*. The time of first cut after sowing is important to obtain maximum number of cuts as well as green forage yield at each cut. Thus, cutting management not only provides information about the regeneration potential of the crop but also growth peak and yield too. Moreover, the cutting management may be responsible for quality and quantity of multicut forage crops and particularly for lucerne forage yield (Kumar & Patel, 2013). Cutting interval of 45 days resulted in improved quality fodder of hybrid Napier with significantly higher crude protein content (10.56 %) and lower crude fibre content (26.81 %). However, cutting interval of 75 days resulted in considerably higher green fodder yield (289.25 t ha^{-1} $year^{-1}$) and significantly higher dry fodder yield (108.19 t ha^{-1} $year^{-1}$) compared to other cutting intervals but it was found non-significant with respect to green fodder yield (Ishrath et al., 2018). Suksombat and Buakeeree (2006) revealed that dry matter yield per cut increased with increasing intervals between harvests, from 1472 kg dry matter ha^{-1} cut^{-1} at 30 days interval to 3122 kg dry matter ha^{-1} cut^{-1} at 50 days interval in hedge lucerne. They also observed increased dry matter and crude fiber per cent with increase in cutting interval from 30 to 50 days. In contrast to this they have also noticed decreased content of crude protein, ash, ether extract and nitrogen free extract percentage with increasing cutting interval. Similarly, significantly higher green forage yield (392.69 q ha^{-1}) and dry matter yield (76.61 q ha^{-1}) of lucerne was recorded by cutting interval of 30 days after common cut than rest of the cutting intervals (Kumar & Patel, 2013). In sweet sorghum, significantly higher yield parameters like fresh forage yield, dry matter yield and quality parameters like crude fibre, ash and sugar were content realized when crop was harvested 90 days after sowing while higher crude protein was recorded when crop was harvested 60 days after sowing (Chattha et al., 2017).

CONCLUSION

To mainstay the productivity and profitability of livestock sector both in terms of health and milk production there is a need to increase the green fodder production per unit land area and time along with good quality. This can be achieved by adopting proper agronomic practices like optimum seed rate, time and method of sowing with suitable genotypes, desired amount of irrigation water, balanced dose of fertilizers and optimum time of harvesting or cutting intervals. Also adoption of cropping systems involving both legumes and cereals fodder crops at proper proportion will helps to obtain higher qualitative as well as quantitative fodder.

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