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GREEN FODDER AUGMENTATION FOR INCREASING ANIMAL PRODUCTIVITY–A REVIEW

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SUMMARY

In Indian agriculture, livestock plays a pivotal role in the development and progress of mankind with crop production programme as a complementary enterprise. India accounts for nearly 20 per cent of the world's livestock and 16.8 per cent human population with only 2.3 per cent of the world's geographical area. In India, there is a deficit of green fodder during summer season. Hence, this paper reveals the various means to augment green fodder production through improved cultivars, scientific fodder management, forage and fodder production as mixed crop, intercrop in gardens, rice fallow areas, natural grass lands, tree fodder, problematic soils, etc. in order to supply the deficit green fodder to maintain livestock's health and productivity.

Key words : Green fodder, augmentation, animal health, productivity

India has the largest livestock population, which accounts for 17 per cent of the world's livestock population. However, livestock productivity is constrained by an acute shortage of feed and fodder. A general agreement is that there is a shortage of 40.4 per cent dry fodder and 24.7 per cent green fodder against the requirement of 650.7 and 761.5 million tonnes for dry and green fodder, respectively (Singh *et al*., 2011). The two obvious approaches to bridge this wide gap between fodder requirement and availability are either to increase area under fodder production or to increase the productivity of existing production systems. Increase in area under fodder production does not appear feasible because of ever increasing demand of food and farmers prefer to grow grain and cash crops even on grasslands and pastures. The second approach imperatively becomes a necessity in the scenario. Although shortage of animal feed and fodder is the major issue that needs to be addressed, feed and fodder quality is not to be ignored. Green fodder availability is very important for livestock health and productivity. This is particularly true in case of dairy enterprises where consistent supply of green fodder is imperative to sustained milk production. In addition to energy, green fodder provides vitamins and minerals, and helps in digestion (Surve *et al*., 2012).

A balanced diet should have suitable proportions of carbohydrates, minerals and protein. Low protein content of non-legume fodder can be supplemented using protein supplements but they are expensive. Legumes can be used in livestock nutrition for their higher protein content and thus providing cost saving. Since legumes have low dry matter, green forage yield, quality fodder can be obtained from intercropping of cereals and legumes compared with their sole crops. Fodder supply can be improved by increasing the fodder production per unit area per unit time. It can be accomplished through various means which are as follows :

1. Unconventional ways to boost forage production

- Nutrient rich, locally adaptable, high herbage yield and quality
- Improved cultivars
- Scientific fodder management and effective utilization

2. Other options

- Forage and fodder in food crops-mixed crop, intercrop, crop rotation
- Inter crop in coconut garden/plantations
- Forage from rice fields e. g. fodder cowpea, bajra, maize
- Forests

- Fallow lands e. g. para grass
- Natural grasslands
- Grasses on terrace (sloppy/hilly terraces)
- Strip cropping and run off e. g. signal grass, anjan grass
- Cover crops-soil conservation e. g. centrosema, stylo, signal
- Marshy lands e. g. para grass
- Tree fodder e. g. subabul, glyricidia, hedge lucerne

3. Forage production in problematic soils

- Acidic soils : Cowpea, oats, fodder maize, napier grass
- Alkali soil : Jowar, bajra, oats, para grass
- Saline soils : Jowar, lucerne, rhodes, para grass
- Waterlogged : Rhodes, para grass
- Eroded land : Stylo, guinea grass
- Dryland or marginal lands : Anjan grass

Green Fodder Augmentation through Improved Cultivars of Dual Purpose Crops

Maize is of significant importance for countries like India, where rapid increase in population has already outstripped the available food supplies. It is often grown in crop livestock farming systems where maize stover makes a crucial contribution to livestock feeding (Thorne *et al*., 2002). Increasing demand for fodder, shortage of arable land and water together with shrinking and deteriorating common property resources is further increasing the demand for maize as a food-feed crop. It is envisaged to cultivate dual purpose maize genotypes that provide good green fodder/stover quantity and quality besides other food items. This also agrees with and confirms the observations of other workers (Desta *et al*., 2000). There is need to develop maize varieties superior in stover production and quality in addition to other food yields. This crop holds great potential in improving smallholder food security and benefits from livestock through superior dual-purpose maize cultivars providing both food and feed. In India, increasing attention is being paid to explore the potential of baby corn for vegetable purposes for higher economic returns to the farmers.

Katoch *et al*. (2009) conducted an experiment to evaluate different maize varieties grown for different uses for seed/fodder yield, biochemical traits and production economics to point out the varieties with high potential giving maximum economic returns. Varieties Early Composite, KH-581, VL-78 and African Tall were observed with higher green fodder yield. The varieties HIM-129, VL-Baby corn-1, VL-Makka-42, Kesari and Seetal gave statistically higher green fodder yield and which varied between 7.40 to 33.60 q/ha. The varieties HIM-129, Early Composite, VL-Baby corn-1, VL-Makka-42, PMH-2, Seetal and VL-78 gave much higher maize green equivalent yield as compared to African Tall and the range varied between 363 and 715 q/ha. The results of the study revealed that the cultivation of dual/multi-purpose maize varieties was better than the cultivation of only fodder type varieties. Such cultivation gives better green fodder yield and maize green fodder equivalent yield. The quality traits of the dual purpose maize varieties were also found to be comparable to the variety African Tall grown solely for fodder purpose.

Bisht *et al*. (2009) reported that the variety BHS-366 produced 9 and 24 per cent more green forage (57.9 q/ha) than BHS-352 and BHS-365, respectively. The forage protein content of different varieties varied from 20 to 31 per cent, whereas P and K content varied between 0.15-0.22 and 2.07-3.01 per cent. However, higher protein yield was recorded from variety BHS-367 (4.63 q/ha) and the lowest from VLB-1 (1.45 q/ha). Thus, it can be concluded that BHS-366 and BHS-365 are superior dual purpose varieties for obtaining good amount of quality green fodder along with a fairly good yield and economic output under mid-hill conditions.

Green Fodder Augmentation through Scientific Fodder Management

The lower yield in fodder crops results due to poor attention towards their cultivation and unscientific way of fodder production. The higher yield in forage crops can be possible to obtain through scientific way which includes seed rate, spacing, nutrient management, irrigation, etc. Among various management practices, nutrient management is most important agronomic practice because forage crops are heavy feeder of plant nutrients and also remove large amount of nutrients from soil. For higher tonnage of fodder requires liberal supplementation of nutrients externally with addition of fertilizers and manures to meet the nutritional requirements of crop and to maximize productivity of crop. Now-a-days fertilizers are costly inputs and their judicious use in food-based cropping systems has taken much attention and less attention is being paid on the use of fertilizer in forage-based cropping systems in the country. The nutrient management based on inorganic alone is not a sound practice also due to concerns related to soil health and quality of ground water. Thus, for sustainable soil fertility and productivity imperative to adopt the strategies with use of low cost, eco-friendly, highly viable and efficient in managing the crop production with no adverse effect on the environments.

Shekara *et al*. (2009) reported that application of 50 per cent recommended dose of nutrients (RDN) through inorganic fertilizer+50 per cent N with available P and K through FYM recorded significantly higher green fodder yield of multicut fodder sorghum (538.64 q/ha) and nutrients.

Patel *et al*. (2009) noticed that mixed cropping of lucerne+pandadiu with seed proportion of 7.5+2.5 kg/ha, respectively, along with application of 30 kg N/ha as a basal and 15 kg N/ha after each cutting produced higher green forage, dry matter and crude protein yields. Inclusion of lucerne in the system improved the quality of fodder due to increase in crude protein content and decrease in oxalic acid content as compared to pandadiu grown alone.

Patel *et al*. (2010) revealed that frequent irrigation at 1.1 IW : CPE ratio, application of N at 120 kg/ha and *Azatobacter* inoculation significantly increased the plant height, tillers per meter row and leaf : stem ratio and produced significantly higher green forage yield, dry matter and crude protein yields of fodder oat as compared to irrigation at 0.7 IW : CPE ratio, 80 kg N/ha and without biofertilizer treatments.

Green Fodder Augmentation through Cropping Systems

Fodder supply can be improved by increasing the fodder production per unit area per unit time. It can be accomplished through introduction of mixed cropping/intercropping in the existing cropping systems, which are primarily food grain purpose. Intercropping, the practice of cultivating two or more crops in the same space at the same time is an old and commonly used practice. It aims at efficiently matching crop demand to the available production resources. There are numerous advantages of intercropping viz., improved herbage quality, increased biomass production, efficient utilization of natural resources i. e. sunlight, moisture, space and smothering of weeds and economic use of inputs besides efficient utilization of land and labour (Tripathi and Gill, 1988). The greatest advantage of intercropping is increased yield and efficient use of available resources. Growing a mixture of crops of different rooting ability, canopy structure, height and nutrient requirement helps make complementary resource utilization by the component crops. Growing a combination of crops rather than a pure crop has been found to produce more yield as well as good quality fodder (Rathore *et al*., 1989). Although cereals are quick growing, leafy, rich in carbohydrates and give a high tonnage of fodder, cereal's forage is poor in protein content which shows their low quality and nutritive value. Low protein and high crude fiber content of non-legume fodders, on the other hand, are low yielder but rich in protein, minerals and vitamins, and have high digestibility. Legumes are very succulent and palatable fodder.

Several scientific studies have demonstrated that crop growth in terms of plant height, number of leaves per plant, fresh weight per plant and dry matter accumulation per plant at various stages of crop growth varies under various intercropping systems. Compared to monocropping, individual plant growth of the component crops in the intercropping systems can either be increased or decreased. Cowpea height generally increases when intercropped with cereals. The height increase is thought to be due to competition offered by intercrop for space and light, whereas cowpea dry matter and yield reduce (Singh, 2003). Kumar and Bhanumurthy (2001) reported that pearl millet, maize and sorghum intercropped with cowpea produced higher fresh and dry weight per plant than their sole crops. Pearl millet produced more leaves than that observed in monocrop. The number of green leaves and leaf to stem ratio in maize were higher in maize+cowpea intercropping as compared to maize alone. On the other hand, cowpea dry matter accumulation and fresh weight per plant decreased in all the intercrop combinations. The number of leaves per plant in cowpea also decreased when intercropped with maize, sorghum and pearl millet. The observed effects were thought to be due to suppressive effect of tall cereals. Cereals reached their full growth in the form of height and canopy development and shaded the cowpea plants depriving them of the resources and solar radiation (Singh, 2003). Similar observations were reported by Manoharan and Subramanian (1993) and

Sharma (1997) in sorghum + guar fodder paired rows and alternate rows cropping system. Khot *et al*. (1992) also reported that 2 : 1 row ratio of cereal+legume provided maximum green forage and dry matter yields when maize or sorghum was taken as main crop.

Green Fodder Augmentation in Garden Lands

In pure coconut garden when palms were spaced at 7.5 x 7.5 m as much as 75 per cent of the available area is not effectively utilized. Besides a pure coconut grove utilizes only half of the available light. It is important to harness those resources to balance nutrient deficits in feed systems and to generate additional income for resource poor farmers by integrating crop and fodder production. Production of fodder under shaded condition is multipurpose. Besides producing fodder, they assist in weed control, maintain or improve soil fertility and control erosion. It is efficient way of forage production, where the light is sufficient to satisfy the high light requirement for photosynthesis characteristics of tropical forage crops. Jayasundara and Marasinghe (1989) described a model in which an old (40 years) coconut plantation (156 trees/ha) was under cropped with Leucaena shrubs and ground cover of Bracharia spp. and *Preraria phaseoloides*. Soil fertility improved and fertilizer cost was cut by 70 per cent, while the coconut yield loss by 11 per cent. Based on this background, to augment forage production intercropping of forage crops was thought of.

Maragatham *et al*. (2006) reported that taking up Guinea grass+Desmanthus (3 : 1 ratio) under shaded condition of coconut plantation recorded maximum green fodder yield of 832.5 q/ha/year followed by guinea grass. Similar trend was observed with respect to dry fodder production also. The higher BC ratio of 1.60 in coconut +guinea grass+Desmanthus (3 : 1) among intercrop situations encourages the possibility of effective utilization of interspace in the coconut plantation. Shekara *et al*. (2010) also revealed that cultivation of cowpea-lucerne recorded significantly higher green fodder yield (650.8 q/ha), dry matter yield (149.2 q/ha) and crude protein yield (26.4 q/ha) followed by horse gram-lucerne (555.6, 133.4 and 24.1 q/ha, respectively).

Green Fodder Augmentation through Agroforestry Systems

There are several definitions of agroforestry given by the experts and scientists working on agroforestry. Looking to the available definition of agroforestry, there is consensus that agroforestry is a land use system which involves trees with agricultural crop/grass and/or animals simultaneously or sequentially. The most commonly used definition is " Agroforestry is a collective name for land use system in which woody perennials (trees, shrubs, etc.) are growing in association with herbaceous plants (crops, pastures) or livestock, in spatial arrangement, a rotation or both; there are usually both ecological and economic interactions between the trees and other components of the system" (Lundgren, 1982). In general, there are 4 or 5 basic sets of components which are managed by human beings in all agroforestry systems. Structurally, the system can be grouped as Agri-silviculture system, Agri-horticulture system, Silvipastoral system and Agri-silvipastoral system.

Gill *et al*. (1997) reported that Leucaena plant growth was slightly better under control (no crops in the interspaces of fruit tree species) as compared to agroforestry systems. On an average, maximum green fodder (112.17 q/ha) and dry matter (35.63 q/ha) yield was recorded under 5 x 5 m, 5 x 10 m and 10 x 10 m fruit tree spacing with crops in the interspaces. Among the fruit tree species, on an average, maximum green fodder and dry matter yield was registered from the interspaces of anar (*P. granatum*) followed by citrus (Kinnow), guava (*P. guajava*) and minimum in case of ber (*Z. mauritiana*). The outcome of this study revealed that introduction of Leucaena in the system besides providing foliage could be used for fodder and green manure in addition to the beneficial effects of sheltering fruit tree species from sun and hot winds.

Nandal and Singh (2001) studied the comparative performance of wheat, lentil and mungbean grain crops and sorghum, cowpea and oats fodder crops under different spacings of Jamun. Results indicated that fodder crops are more tolerant to shade than grain crops and the yield reduction in crops was higher during the rainy season than the winter season. Decrease in plant height and stem diameter of fodder crops under Jamun resulted in their decreased fodder yield. This was due to greater competition for light and other growth resources during the rainy season on account of active growth and full leaf stage of Jamun. Whereas during the winter season, Jamun trees became dormant and also shed some leaves.

Gill (2003) studied the introduction of *Leucaena* *leucocephala* in mango-based agroforestry systems. The results on *Leucaena* growth and forage yields revealed that mango orchard interspaces could successfully exploited by introducing fast growing multipurpose nitrogen fixing fodder trees without having any adverse impact on the growth of mango orchard. Besides fodder yield, additional profits can be achieved through fuel yield of the plant i. e woody portion not fit for fodder. Leucaena being N_2 fixing trees have many additional advantages including protecting the young mango orchard from excessive sunshine and hot winds during summer months. Such attempts can ensure in promoting sustainable agriculture, which lead to increase farm productivity on per unit area basis and at the same time reducing the risk of hazards, which in turn affect the environment favourably.

Gill and Ajit (2005) studied the performance of fodder cowpea in the interspaces of mango varieties. Results indicated that on pooled data basis plant height, collar diameter and plant canopy were highest in mango variety Langra, followed by Mallika, Deshari and lowest in Amrapalli. Langra registered a plant height of 2.97 m, collar diameter of 10.92 cm and plant canopy of 3.17 m on an average. The maximum green and dry fodder yield of cowpea was recorded with mango variety Deshari (170.62 and 30.67 q/ha). Interestingly on pooled data basis, minimum green (136.12 q/ha) and dry (24.55 q/ha) fodder yield was recorded with pure planting of cowpea. However, these results are in close confirmation with the work as reported by Rajput *et al*. (1986) and Gill and Gangwar (1992).

Green Fodder Augmentation in Problematic Soils

The requirement of food and forages for the ever increasing human and animal population has created an enormous pressure on 328.8 million hectares land of the country. As such, the possibility of increasing area under good lands for forage production seems to be remote owing to preferential food need for human beings. The area required to meet out the projected fodder shortage of 40 per cent is about 10 million ha and presently India has only 6.9 million hectare of land under fodder production which is about 4 per cent of the total cultivated area. The possibility of increasing deficit fodder supply by adopting latest forage production technologies on the available cultivated area is limited. However, about 8.5 million ha land affected by salinity and sodicity (Tripathi and Hazra, 1996) distributed throughout the country can be capitalized as these soils can require large investment for their reclamation for cultivation of arable crops. Hence, to meet out the forage demand, the marginal and problem soils including salt affected soils which are often designated as barren, waste and marginal soils are the only source to be tapped.

Kumar and Yadav (1999) studied the evaluation of forages under saline and alkali soil condition. They noticed that under shallow water table condition (EC 2 8 dS/m), Karnal grass (*Leptochloa fusca*), Gatton panic and Blue panic (*Panicum antidotale*) performed better, but under waterlogged conditions, Para grass (*Brachiaria mutica*) outyielded these grasses in biomass production. In alkali soil condition, Karnal grass and Rhodes grass are most tolerant to high alkalinity. These two species can be grown up to ESP 60 without any yield reduction. The order of tolerance for alkalinity of remaining grasses was Bermuda grass > Gatton panic > Para grass.

Yadav *et al*. (1997) reported that on moderately saline soils, the mixtures of Egyptian clover with mustard and oat outperformed their pure stand in green matter, dry matter, protein content, ash content and protein, ash and organic matter yield. The pearl millet grown alone or its mixture with mustard and oat resulted in higher production and better quality of green and dry forage.

Kumar (2006) noticed that in alkali soils and with alkali water irrigation, sorghum - Sudan grass should be sown in the month of June rather than April and May because after June rainfall starts which contributes maximum to its water requirement and owing to which less of alkali water is used reducing the harmful effect on soils and plants. Broadcasting the seed is better method of sowing under such situations.

Jain and Sood (2006) studied the forage and seed production from seasonally waterlogged wastelands. Results revealed that Setaria was found to tolerate the seasonally waterlogged conditions and grown successfully. The mean fresh and dry forage yields obtained from Setaria and Setaria+clover plots were 54.28 & 61.18 and 14.27 & 16.40 t/ha. The Setaria grass grown on double spade raised slice produced significantly higher fresh (69.08 t/ha) and dry forage yield (18.58 t/ha). Among cutting managements, seed after two cuts recorded significantly higher fresh (64.00 t/ha) and dry forage yield (17.11 t/ha).

CONCLUSION

A review of scientific literature showed that green fodder augmentation can be achieved through growing of dual purpose crop varieties, scientific management of fodder crops, inclusion of fodder crops in the existing cropping systems, garden lands, agroforestry systems and in problematic soils, in order to supply the deficit green fodder to maintain livestock health and productivity in different months of the year.

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