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A Review: Energy analysis of different fodder crop production in India

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ABSTRACT: In a developing country like India, energy is a crucial element for agricultural productivity and economic growth. The amount of energy consumed and opinions of the GDP are closely related. Efficiency in administration and production on the dairy farm depends heavily on energy. The present review focuses on thorough analysis of the body of existing research and numerous reports by governmental and non-governmental organizations. On just 2.3% of the planet's surface area, India supports over 20% of the world's livestock population and nearly 17.5% of its human population. The population of people is growing at a rate of 1.6% annually, but the population of animals is growing at a rate of 0.66% annually. Both the human and animal populations are growing, and they are vying ferociously for the same land resources to produce food and fodder, respectively. Thus, only 4% of the nation's total cultivable area is used for growing farm fodder. Current shortages in the nation include 44% of concentrate feed ingredients, 10.5% of dry crop leftovers, and 35.6% of green fodder. It is exceedingly difficult to increase the amount of land that is used for fodder agriculture. The cropping system with fodder crops offers a potential solution to the fodder issue since it makes better use of the available resources.

Key words: Cropping system, livestock, marginal farmers, production of fodder

Population expansion has compelled humanity to put more emphasis on food grain production in order to meet the growing demand. Animal husbandry includes green fodder as a crucial element(Lal *et al.*,2020)**.**In order to address the primary issues confronting humanity, such as human demography, food security, climate change, energy consumption, biodiversity, and the environmental footprint of human activities, sustainable agriculture is essential (Ahamed *et al.*, 2023) The population of the world, which is currently 7.6 billion, is expected to increase to 8.6 billion in 2030, 9.8 billion in 2050, and 11.2 billion in 2100, according to new United Nations data published today. It is expected that the world's population will increase even if fertility rates continue to decline to maintain the current trend and rise by roughly 83 million people annually (Makarigakis and Jimenez,2019). Humanity has been motivated by population increases to focus more on food grain production in order to meet the growing demand. In order to address the major issues facing humanity, such as human demography, food security, climate change, energy consumption, biodiversity, and the environmental impact of human activity, sustainable agriculture is essential. By 2025, the 7.9 billion people who currently inhabit the planet will number 9.8 billion (Nations, 2015).As compared to 2012, it is anticipated that livestock units will rise by up to 50%, while the amount of arable land per person will fall by about 23% (FAO, 2018) Livestock plays a significant role in the national economy and is a major source of income for marginal and landless farmers. At a constant price, the cattle industry has expanded continually at a compound annual growth rate (CAGR) of 7.93%. Around 3,350 households benefited from the project, which started in 2020, and it prevented the deaths of their cattle. Depending on the conditions and resources available locally, various low-tech greenhouse structures are primarily utilized for the production of fodder. According to a study, a low-tech net house might reduce the amount of electricity

used by a high-tech greenhouse to produce 600 kg of maize fodder per day (Naik *et al.*, 2012). The land allocation for cultivation of green fodder is limited to only 5% of the gross cropped area by 2020. India would require a total of 526, 855, and 56 million tons of dry matter, green fodder, and concentrates, according to (Dikshit and Brithal 2010).2020–21, which is comparable to the CAGR of manufacturing at 4.93% (at constant price) and services at 4.82% (at constant price), and in contrast to the agriculture (crop sector) CAGR of 2.05%.In 2020–21, agriculture (the crop sector) contributed 8.96% (at constant prices) of total GVA, whereas the livestock sector contributed 4.90% (at constant prices) of total GVA. Energy requirements for seedbed preparation are important objectives of sustainable farming. Therefore, reducing tillage operations to decrease energy consumption and increase energy efficiency will be the aim of sustainable farming

Indian livestock production at the moment

Fodder production in India varies greatly across the country, and its use is determined by cropping pattern, climate, socioeconomic conditions, and the type of cattle. Cattle and buffaloes are often fed fodder from cultivated regions, with collected fodder and top feeds supplementing it to a small extent (Shashikala *et al.*, 2017). Fodder crops are cultivated or harvested for feeding the animals in the form of fodder (cut green and fed fresh), silage (preserved under anaerobic conditions) and hay (dehydrated/ dried green). Sorghum (2.6 M ha) and Egyptian clover (1.9 M ha) account for roughly 54% of the total cultivated fodder area in the kharif, rabi and zaid seasons, respectively (Dagar, 2017). Farmers are growing grasses and legumes including hybrid Napier, guinea grass, paragrass, velvet bean, stylo, etc. in many areas. Farmers with small ruminants, in particular, pick tree-top fodders in times of scarcity. The area covered by permanent pastures and other grazing land is 10.34 M ha (Directorate of Economics and Statistics, DAC and FW, 2020) and has been decreasing over time, with the tendency likely to continue. The productivity of pastures has also been falling due to overgrazing (Pathak and Dagar, 2015). Crop residues are expected to provide 54% of total fodder, while rangelands provide 18% and only 28% is met from cultivatedfodder crops (Hegde, 2010). There is currently a net deficiency of 35.6% green fodder, 10.95%dry fodder and 44% concentrate feed materials in the country by 2025, the demand for green and dry feed will be 1012 and 631 million tones, respectively (Figure 1). In the year 2025, with the current rate of expansion in fodder supplies, there will be an 18.4% deficit in green fodder and a 13.2% shortfall in dry fodder (Figure 2). Green fodder supply must rise at a rate of 1.69% per annum to satisfy the deficit; however, the area under cultivated fodderaccounts for only 4% of the total cultivated land (8.4 million ha) in the country, and has remained unchanged over last few decades. (Dagar, 2017; Halli *et al.*, 2018; Meena *et al.*, 2018). Different states are affected by the shortfall in different ways. While the shortage is minor in Punjab and Haryana, where fodder accounts roughly 8% of total cultivable land, it is severe in arid areas such as Bundelkhand, where fodder is grown on less than 2% of cultivable land. Despite the fact that various government agencies have implemented several plans to alleviate the fodder production, there is no reputable survey or study that evaluates the situation of fodder production on ground, and central/state governments dismiss the scarcity of fodder on the thin premise that no comprehensive data on fodder production exists. Whatever researches are available in the public domain are merely speculation (Jitendra, 2017). Crop residues, cultivated fodder, and fodder from community resources like permanent pastures and grazing lands are the three main sources of fodder in India. Feed and fodder accounts for over two-third of total animal

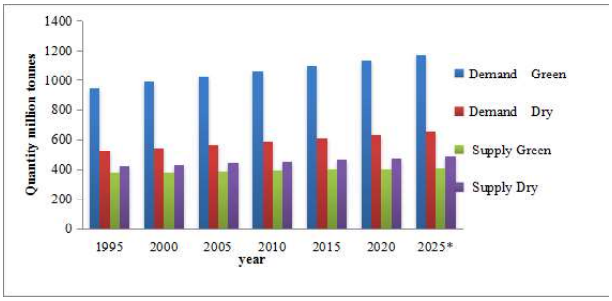


Fig.1: India's annual demand and supply for dry and green fodder

production costs (Ginwaln *et al.*, 2019), hence, any effort to increase feed and fodder availability and economizing the feed cost will result in better remuneration to livestock farmers.

CHALLENGE

The expansion of India's dairy sector is driving the increase in the cattle (both bovine and Asian domestic water buffalo) herd numbers. In marketing year (MY) 2023 (January-December) herd numbers have grown to 307.5 million head as compared to 306.7 million head in 2022.Livestock population expanded from 512.06 million in 2012 to 535.82 million in 2019, representing a 4.6% increase over the last census with an annual growth rate of 0.66%. However, the indigenous cattle count has decreased by 6% since previous census, the total number of exotic/crossbred cattle has increased by 26.9% during the same period. Furthermore, the country's poultry population increased by 16.8% from previous census to 851.81 million at present; owing primarily to 46.8% increase in backyard poultry birds (317 million). The number of buffaloes in the country has increased to 109.85 million, up from 108.70 million in 2012. The country now has a total of 109.85 million buffaloes as compared to 108.70 million in the 2012 census. On the other hand, the goat population, increased by 10.1% over the previous census to 148.88 million. The total sheep count in the country in 2019 was 74.26 million, an increase of 14.1% over the previous enumeration. Among the states, Uttar Pradesh ranks first with the livestock population of 67.8 million followed by Rajasthan (56.8 million), Madhya Pradesh (40.6 million) and West Bengal (37.4 million). This increasing livestock population puts further pressure

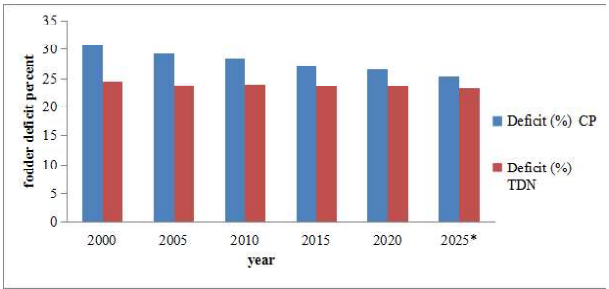
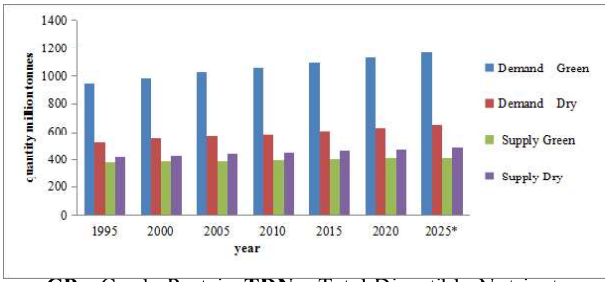


Fig. 2: Year wise green and dry fodder deficit

on limited land resources for green fodder supply. Maintaining such a large herd of animals with their optimum productivity realization is a major challenge.

Requirement and availability fodder crop in India

Non-availability of quality seeds of fodder crops is also limiting fodder productivity in India. Only 25%–30% of the required quantity of quality seeds is available in cultivated fodders and less than 10% in rangeland grasses and legumes (figure.3). So, there is need to evolve superior varieties of fodder crops with high yield and quality, and also development of new technologies for multiplication (Thomas and Thomas, 2019). The fodder seed shortage can be addressed by intensifying the planning and strategy for uplifting the production of fodder seeds. This includes creating awareness about the importance of using high quality seed of improved varieties, increasing the seed replacement rate from the present 2%–3% to at least 10%, establishing an appropriate seed chain to produce sufficient quantity of certified seed for farmers, improving the seed chain network, seed production through farmer participatory approach, improving proper marketing facilities, conducting research to increase the ovule to seed ratio in fodder, channelizing the existing demand towards entrepreneurship development, improving crop management, village seed banks development, utilizing forest waste lands for the seed production, and application of new research innovations such as in vitro maturation, exogenous chemical application, high density nursery for rooted slip production, harvesting based on morphological indicators, hormonal spray for enhancing seed setting, seed pelleting in range grasses *etc*. (Palsaniya *et al.*, 2010; Vijay *et al.*, 2018). seed production is quite difficult in fodder crops as compared to other crops. There are mainly two systems of fodder seed production viz., opportunist system, an informal system in which fodder particularly range species' seed harvesting is done from existing grasslands/ rangelands and specialist system, in which seed production fodder crop is planted for seed production. This system requires technical guidance



CP : Crude Protein **TDN :** Total Digestible Nutrients

Fig.3: Requirement, availability and deficit of (CP) and (TDN) in India

to grow the crop. For successful working of this system, it requires an assured market and reasonable prices for the seed (Malviya *et al.*, 2013). The seed production in a specialist system requires a certain package of practices to follow for enhanced seed yield. To achieve standard seed quality, proper isolation has to be followed along with regular roguing off-types volunteer plants.

Fodder crops in cropping systems

Besides continuous cultivation of rice-wheat causes deterioration of soil health, ultimately resulting in decreased production, the year-round availability of green fodder is a major challenge in the country. Therefore, diversification of rice-wheat systems with fodder crops on a rotational basis, as suggested by various workers (Banjara *et al.,* 2021; Banjara, Bohra, Kumar, Singh, *et al.*, 2021; Singh *et al.*, 2019), can be adopted as a strategy for ensuring year-round fodder availability in India. The need for diversification of age-old rice-wheat cropping systems has also been reported by various workers (Bohra *et al.*, 2007; Singh *et al.*, 2019). The year-round supply of green fodder will be a boon to farmers for increasing their farm production and profitability, as majority of the households (71%) undertake crop +livestock farming. Sudan grass (*Sorghum* × *drummondii*[Steud.] Millsp. and Chase) with its tremendous capacity to produce higher biomass is a good option during summer and rainy season (Hazary *et al.*, 2015; Yadav *et al.*, 2007). In the subsequent *rabi* season, the choice for the green fodder crops are berseem, oats (multi-cut) and dual-purpose barley (Kaur *et al.*, 2018). Napier grass (*Pennisetum purpureum* Schumach.), having quick re-growth after cutting, is a good option as perennial fodder crop (Negawo *et al.*, 2017; Rusdy, 2016). Depending upon the area under fodder crops and the composition of crop + livestock integrated farming system, the choice of crops can be made to ensure year year-round fodder availability. The cropping system with fodder crops provides a potential alternative to overcome the fodder problem as it utilizes the resources more efficiently. It also provides a balanced diet to the animals, due to inclusion of legume and cereal fodder crops together (Kadam *et al.*, 2017).

Different fodder crop production from marginal lands

Compared to small, medium, and big farmers, marginal farmers had the highest yields of the green fodder crops sorghum, bajra, barseem, maize, and Napier. In contrast, small and medium farmers produced more green fodder from cowpeas than marginal and big farms did. Fuel wood, fodder, and other items cannot be produced on the restricted arable area that can be used for crop production. To supply the demand for these related products, India must employ its approximately 121 million hectares of degraded land through agro forestry systems. Large parts of arid and semi-arid regions are also still devoid of vegetation because of salinity or a lack of water. It has been determined and tested that a number of forest tree, shrub, and grass species may flourish in these troublesome regions. By using the right planting methods and stress-tolerant species, these can be converted into a sustainable fodder-producing vegetative cover (Dagar and Minhas, 2016). Numerous nitrogen-fixing tree and fodder species can be cultivated effectively in erosion-prone locations, and the majority of the rainwater (which is present during a few wet spells) can be stopped into the deeper soil strata. In this approach, trees use the deeply percolated water and grasses and shrubs use the moisture from the upper 2 m strata. As a result, dry places can develop deep-rooted species like Khejri (*Prosopis cineraria*, known as the “life tree of the desert”) and the shrub *Ziziphus nummularia*, both of which make good feed.Without hindering the establishment of trees, these grasses

may yield 2.2–3.8 tonnes of dry fodder per hectare per year (Dagar, 2017). India has open forests with a canopy density of less than 0.4 on about 29 million hectares of land. This wide stretch of land can be used to grow fodder without causing any harm to the existing trees, much like an understory on partially shaded terrain. To improve the year-round fodder, special attention should be paid to bunds, ponds, embankments, basins of plantation and horticulture crops, hedges with fodder crops, and other non-cropped areas of agricultural land that are not farmed.

CONCLUSION

The review highlights several research studies on various green fodder crops in India. The study reflects the feed consumption rates for different livestock functions at the national level, and associated demand for different types of feed. It was concluded that the land allocation for cultivation of fodder crops is approximately 5% of the gross cropped area. At present, there is a deficit of 62.7% green fodder, 23% dry fodder, and 64% concentrate feed. The estimates of demand could help in resolving the controversy regarding the utilization of food grain used as feed, which varies widely depending on the assumptions made. These estimates will provide a sound basis for determining the input-output relations for the livestock sector. It can also used by the Central Statistical Organization (CSO) for the estimation of the gross domestic product (GDP) from the livestock sector. Estimates of demand for different feeds could play a pivotal role for policymakers to design trade strategies for maximizing benefits from livestock production. Finally, the feeding practices do not change in the short run, and the estimated feeding rates could serve as a benchmark that can be updated periodically to estimate the feed demand.

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