Fodder scenario and hortipastoral opportunities to enhance fodder production in India

Nagaratna Biradar*, C Lakshmi Devi*, Vinod kumar*, Narendra Kulkarni*, Anil Kumar G.K. †, Guledagudda S S†, Bheemappa A†
*ICAR-Indian Grassland and Fodder Research Institute, Southern Regional Research Station, Dharwad-580005, Karnataka, India
†University of Agricultural Sciences, Dharwad-580005, Karnataka, India

Keywords: Dry matter; fodder crops; livestock; fodder shortage; states of India

Abstract.
Food grain production and livestock production are closely related in India as crop-residue forms the major source of fodder for livestock. It's thus assumed that increase in food grain production has positive effect on availability of dry matter to the livestock. Using land use classification, crop production (2015 to 2020) and livestock census (2019) data, dry matter (DM) availability for livestock for 28 states of India was estimated. Hortipastoral opportunities by estimating area available under orchards in southern India were done to assess the possibility of introducing fodder crops in orchards. Some of the fodder crops were introduced in orchards of livestock farmers to know how fodder crops address the issue of fodder availability at household level. The lowest DM available state was Assam (52.80 % availability) and highest available state was Haryana (110.80 %). Eight states have surplus DM (+110.80% to +2.3%). Twelve states experience DM deficiency (-2.96 to -47.20%). Inter spaces in orchards, a niche to cultivate fodder crops to reduce such fodder shortage, estimated to produce 67.13 MT of green fodder sufficing yearly requirement of 13.57 million Adult Cattle Units. Adult Cattle Unit is a reference unit which facilitates the aggregation of livestock from various species and age using specific coefficients derived based on the nutritional and feed requirement of each type of animal. Perennial fodder crops were introduced to 450 Mango and Coconut farmers (from 2016-2021) that reduced fodder shortage (50.6±4.39 to 9±1.64%).

Introduction
India has progressed consistently over the years in food grain production. Its food grain production in 2015-16 was 251.54 million tons which increased to 308.65 million tons in 2020-21, indicating cumulative growth of 22.07% (2015-2020). Livestock numbers in the country witnessed growth of 4.01% from 2012 to 2019 (20th Livestock census, 2019). India is world's highest livestock owner (535.78 million), first in cattle and buffalo population in the world (109.85 million), second in goat population (148.88 million) and third in sheep population (74.26 million) (Anonymous, 2019). India sustains 16% of world human population on 2% of total geographical area. So, growth of livestock sector is pivotal to sustain food production in the country. Food grain production and livestock production are closely related as crop-residue obtained from food crops forms the major source of fodder for livestock. While crop residue production is impotant to sustain livestock in the country, equally important is to ensure that green fodder is fed to livestock to realise potential livestock production. India's livestock productivity is not on par with that of the world. However, with small land holdings, farmers are reluctatnt to allocate land for fodder production. So, a study was taken up to understand the fodder scenario of the country and to explore the potential of inter-row spaces of fruits and plantation crops for fodder cultivation.

Methods
This study was conducted in three stages. The first two stages made use of secondary data to estimate state wise dry matter availability and estimate fodder production from inter-row spaces in orchards. Third

stage involved introducing fodder crops in orchards of livestock farmers and recording farmers' observation on addressing fodder shortage.

Secondary data was sourced on year wise crop production (2015-2020) and land use classification from Directorate of Economics and Statistics, Government of India (GoI) and livestock data from 20th livestock census report from Department of Animal Husbandry and Dairying, GoI. Five years crop production data was averaged for each crop to eliminate any production variation due to climatic variabilities. Average values derived were used to estimate dry matter production from different crops by following FAO suggested procedure. In India, land is classified under 7 categories. They are gross cropped area, forest area, permanent pastures, cultivable waste lands, current fallows, other fallows and area under miscellaneous tree crops. The recent land classification data (2019-20) for 28 states were collected from Directorate of economics and statistics. Using this data, DM production was estimated as per the procedure suggsted by FAO (FAO, 2012). Total dry matter availability was sum of estimated dry matter from crop production and land use classification. Feed requirement is a quantity of feed required to be given to the livestock in the course of animal husbandry. So, this requires data on total number of livestock in the state. Secondary data on livestock types and numbers for cattle, buffalos, goat and sheep and by age (< and > 1.0 year for small ruminants and < 1.0 year, 1.0-2.5 years and > 2.5 years for large ruminants) was sourced from 20th livestock census, 2019 which was the most current available data from Department of Animal husbandry and Dairying, GoI. It was sourced for all the 28 states of India. This livestock data were converted into standard Adult Cattle Units (ACUs) using the conversion factors suggested by Ramachandra et al. 2007. Adult Cattle Unit is a reference unit which facilitates the aggregation of livestock from various species and age using specific coefficients derived based on the nutritional and feed requirement of each type of animal. Using total ACUs, the total annual feed requirements in terms of DM for each state of India was estimated by multiplying with 2.555 tons (7 kg DM/day/ACU) per ACU per day (Anandan and Sampath 2005).

Esimation of horti-pastoral (fodder production) potential in southern India (comprising 4 states-Andhra Pradesh, Karnataka, Tamil Nadu and Kerala) was done based on data on area under orchards/plantation crops. Only those fruit/plantation crops having row to row spacing of more than 6 meter was considered. Ten percent of this area was considered under young orchards (as farmers cultivate food crops in young orchards), hence deducted from total area to obtain available area for estimation of fodder production. Three metre (3 m) space was required for preparing tree basins, so deducted from the spacing followed between the tree rows. For instance, spacing followed for Mango is 10 m X 10 m. Deducted 3 meters from 10 meters and a factor of 0.7 was used to multiply with the area under old mango orchards to arrive at area available for fodder cultivation. A conservative figure of 40 tons of green fodder production per hectare per year was taken to estimate the total green fodder production (Dikshit and Birthal 2010).

Farmers having Mango and Coconut orchards were selected from Karnataka and were given one day training on fodder production. During the training, farmers were asked to select those fodder crops which they desire to grow. Four fodder crops-perennial fodder sorghum, Bajra Napier Hybrid, Guinea and grazing guinea were introduced to 450 Mango and Coconut farmers (from 2016-2021) and their observations were recorded using questionnaire.

Results and Discussion

Distribution of states based on dry matter (DM) availability in India

Analysis of 28 states of India for DM availability was done in the study. Out of these 28 states, 12 states belonged to surplus (>100%) DM available category. Six states belonged to adequate (80-100 %) DM available, 6 states belonged to moderately adequate (60-79%) DM available, 3 states belonged to deficient

(40-59%) DM available and one state belonged to severely deficient (<40%) DM available categories. Country as a whole found to be in adequate DM available category. The lowest DM available state was Jharkhand with average DM availability of 28.25 per cent and the highest DM available state was Punjab (303.82%). Range of DM availability was 102.34-303.82 % in surplus, 82.57-97.46 per cent in adequate and 69.42-78.05 per cent in moderately adequate states. In deficient and severely deficient states, it was 42.33-59.08 per cent and 28.25 per cent, respectively (Table 1).

Table 1. Distribution of states based on dry matter (DM) availability in India

Categories	Criteria	Number of states	DM (%) range
Surplus	>100 % DM availability	12	102.34-303.82
Adequate	80-100 % DM availability	6	82.57-97.46
Moderately adequate	60–79% DM availability	6	69.42-78.05
Deficient	40–59% DM availability	3	42.33-59.08
Severely deficient	< 40% DM availability	1	28.25
Lowest available state		Jharkhand (28.25%)	
Highest available state		Punjab (303.82%)	
Adequate		All India (90.30%)	

State wise dry matter availability in India

Spatial distribution of states as per DM avaialbility is presented in Figure-1. Results indicated a wide variation across the states. Nagaland has highest DM availability among all the states of the country. It has nearly 10 times surplus fodder than its requirements. Mizoram on the similar lines has 8 times surplus fodder than its requirement. Availability of large area like pastures, wasteland and fallows for livestock grazing coupled with minimum livestock holding are the reasons for present findings. Punjab and Haryana have surplus DM, the former has two times surplus and the latter has one time surplus fodder than the required quantity. These two states have earned the name of food bowl of India. Rice and wheat are grown in large areas which contribute substantially for the crop residue availability. Uttarakhand also belonged to surplus DM available category. This particular state has abundant area under forest. Farmers collect fodder from the forest in Uttarakhand and 30.08 percent respondents solely depend on forests (Singh et al. 2017). Maharashtra state has 46.39 percent surplus DM. The state has witnessed very good growth in food grain production (cumulative 46% from 2015-20) contributing for surplus dry matter availability. Surplus DM of 43.28 percent is available in Arunachal Pradesh. Reason being extremely low livestock density (3 ACU/km^2). Rice is one of the important crops in Tripura state which has surplus DM. Uttar Pradesh, the largest state in the country also has 21.82 percent surplus DM. Prevalence of Sorghum-Berseem-Sorghum and/or Sorghum-Oat-Sorghum cropping systems for fodder production in all three seasons in some parts of the state (Meena et al. 2011 and Mishra et al. 2007) could be the reason.
Six sates- Tamil Nadu, Andhra Pradesh, Rajasthan, West Bengal, Karnataka and Telangana belonged to adequate DM available categories with the mean dry matter availability of 90.67 %. Some of these states also have relatively high livestock density particularly West Bengal (60 ACU/ km^2) and Telangana (74 ACU/ km^2). Thirunavukkarasu et al. (2011) reported dry fodder deficit of 0.57 ton/ACU in Tamil Nadu state. Six states-Bihar, Chhattisgarh, Gujarat, Odisha, Meghalaya and Kerala experienced moderately adequate DM availability. Except Meghalaya and Kerala, which are smaller states, Bihar (176 ACU/Km^2), Gujarat (81 ACU/km^2), Chhattisgarh (68 ACU/km^2) and Odisha (53 ACU/Km^2) have higher livestock density contributing for more DM requirement leading to moderate DM available status. The mean percentage DM availability of these states was 72.26 %. Jammu and Kashmir, Manipur and Assam belonged to deficient DM availability with mean percentage availability of 51.40 percent (Table 1). All these states witnessed negative food grain production during the 2015-20. Besides, these states cultivate

more of orchard and plantation crops. Jharkhand belonged to severely deficient category with DM deficiency of 71.75 percent due to high livestock density.

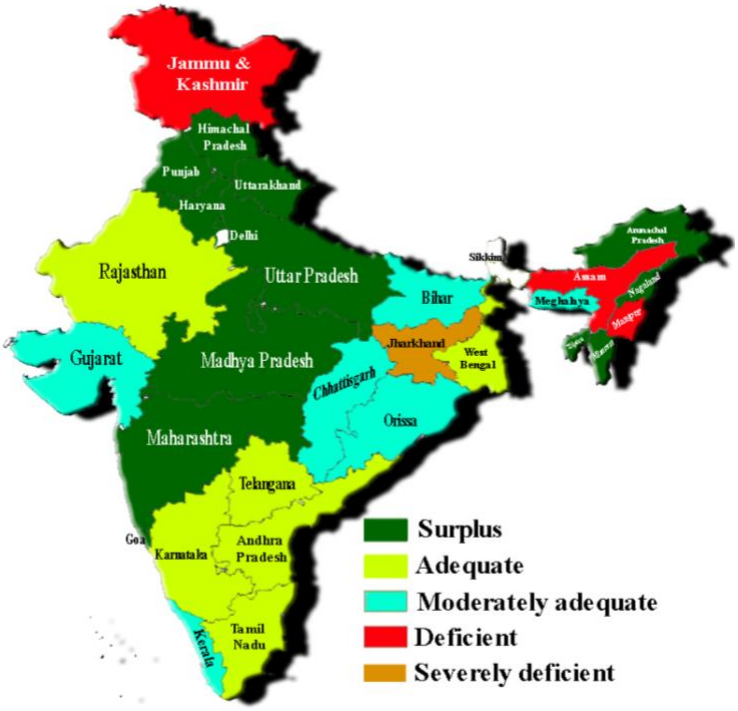

Figure 1. Spatial arrangement of different states of India based on estimated dry matter availability

Estimated area under fruits and plantation crops for fodder production in Southern India

Estimated green fodder production utilizing inter-row spaces in fruits and plantation crops was highest in Andhra Pradesh (33.30 million tons) followed by Karnataka (14.43 million tons), Tamil Nadu (12.03 million tons) and Kerala (7.37 million tons). It is thus estimated that by using this niche area, these states can together produce 67.13 million tons of green fodder sufficing the yearly green fodder requirement of 13.57 million Adult Cattle Units (Table 2).

Table 2: Estimated green fodder production from inter row spaces of fruits and plantation crops in southern India

States	Estimated GFP (million tons)	Estimated LS nos (million ACUs)
Andhra Pradesh	33.3	7.39
Karnataka	14.43	2.64
Tamil Nadu	12.03	2.19
Kerala	7.37	1.35
Total	***67.13***	***13.57***

Hortiposture in farmers' fields to adress fodder scarcity

Four fodder crops-perennial fodder sorghum, Bajra Napier Hybrid, Guinea and grazing guinea were introduced in the Mango and coconut plantations of 450 livestock farmers which helped them to reduce average fodder shortage from 50.6±4.39 to 9±1.64%. They expressed that it resulted in additional benefits of maintaining orchard hygiene, suppressing weed and containing soil erosion. These farmers, besides inceasing area in their own orchards under fodder crops, also shared the seed and planting material to other farmers. So, intra-farmer and inter-farmer spread in terms of yearly growth percentage was 109.73

% (39.19% to 162.14%) in area and 103.63 % (40.00%-145.45%) in terms of number of farmers who took seed/planting material.

ConclusionWide variation in dry matter availability in different states of India was observed. Spatial arrangement of states, as per the dry matter availability revaled that, most of the surplus DM available states are located contiguously. This provides advantage to plan movement of dry matter from these states to other states. Further, hortipasture provides a great scope in Southern India. Introduction of fodder crops in inter-row spaces of orchards/plantation crops, which otherwise left unutilised, helped to reduce fodder shortage considerably. Results of the present study thus provide a way to plan and address the fodder scarcity in country.

Acknowledgement
Authors duly acknowldge the support of Director, ICAR-Indian Grassland and Fodder Research Institute, Jhansi (Uttar Pradesh), India for carrying out this study.

References
Anandan, S., Raju, S. S., Angadi, U. B. and Ramachandra, K. S. 2005. Status of livestock and feed resources of Malnad region in Karnataka. *Animal Nutrition and Feed Technology.,* 5: 99–105.

FAO, 2012. The Indian feed inventory, retrieved on www.fao.org/ docrep/016/ 13043e/i3043e04.pdf on 14.12.201.

Anonymous, 2019. Role of livestock. https://vikaspedia.in/agriculture/livestock/role-of-livestock-in-indian-economy.

Dikshit, A. and Kand Birthal, P. S. 2010. India's livestock feed demand: Estimates and Projections. *Agricultural Economics Research Review*., 23: 15-28.

Meena, L. R., Mann, J. S. and Meena, R. K. 2011. Performance evaluation of cowpea and *Cenchrus setigerus* intercropping and nitrogen supplementation through organic and inorganic sources in Aonla (*Emblica officinalis* Gaertn) based horti-pasture system. *Range Management and Agroforestry.,* 32: 33-39.

Mishra, A. K., Shivrudrappa and Ramakrishna, 2007. Strategies for enhancing forage production in rain fed regions of India. *Range Management and Agroforestry*., 28: 368-370.

Ramachandra, K. S., Taneja, V. K., Sampath, K. T., Anandan, S. and Angadi, U. B. 2007.Livestock feed resources in different agro-ecosystems of India: Availability, requirement and their management. National Institute of Animal Nutrition and Physiology, Bangalore, India.

Singh, B. P. S. N., Chander, M., Akand, A. and Sachan, R. 2017. Integrated fodder and livestock development in Uttarakhand: NGO's initiatives. *Journal of Rural Development.*, 36 (2): 231-242.

Thirunavukkarasu, M., Sankaran, V. M., Kathiravan, G. and Karunakaran, R. 2011. Estimating dry fodder availability and requirement for bovines. *Indian Journal of Animal Sciences*., 81(7): 744-750.