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K Naveena
MVSC (Animal Nutrition), Veterinary Surgeon, Animal Care Land, SVVU, Tirupati, Andhra Pradesh, India

Y Pradeep Kumar Reddy
Assistant Professor, Center for Continuing Veterinary Education & Communication, College of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India

P Pandu Ranga Reddy
Assistant Professor, Department of Animal Genetics and Breeding, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India

MV Dharma Rao
Scientist and Head, Livestock Research Station, Sri Venkateswara Veterinary University, Mahanandi, Andhra Pradesh, India

Corresponding Author
K Naveena
MVSC (Animal Nutrition), Veterinary Surgeon, Animal Care Land, SVVU, Tirupati, Andhra Pradesh, India

Appraisal of livestock sustainability by quantifying the feed resources: An insight into data of Chittoor district

K Naveena, Y Pradeep Kumar Reddy, P Pandu Ranga Reddy and MV Dharma Rao

Abstract
An appraisal of livestock and poultry feed resource availability was done based on secondary data in Chittoor district of Andhra Pradesh state, India. Among the large ruminants, cattle population was highest compared to total buffalo population. Crossbred cattle outnumbered indigenous cattle with 3.4:1 ratio. Poultry production was predominant with large scale commercial poultry farms of broilers and layers in 1.3:1 ratio. The region possesses overall DM availability of 5.10 million tonnes (Mt) from various feed resources. Major portion (35.98%) of the green DM forage availability is contributed from the forest area in the district followed by gross cropped area (33.12). Crop residues contributed to 63.73% of total DM supply for livestock in the region. Straw from sugarcane crop, groundnut followed by bajra are the major cereal straws available in the region while the ground nut straw is a major legume straw. The contribution of the green fodder, dry fodder, and concentrates for the overall DM availability in the region is 31.96, 68.04, and 0 respectively. The DM availability per RLU/day for the region as a whole is 5.10 kg. The study revealed that there was a moderate DM availability in Chittoor district (72.88). The percentage availability of dry matter, green forages, dry forages, and concentrates per RLU for the region are 5.10, 1.63, 3.47, and 0, respectively. Complete unavailability of concentrates in the region depicts heavy demand of concentrates for poultry, owing to the presence of higher poultry population in the region. Thus, it could be concluded that there was a severe shortage of concentrates to meet the requirements of both livestock and poultry. Although the region is self-sufficient in terms of dry forage availability, majority of dry forages are nutritionally poor straws. Hence, suitable strategies should be developed for the efficient utilization of existing feed and fodder resources to improve animal productivity in this region. Furthermore, the correlation analysis revealed significant positive co-expression of rainfall with buffalo and poultry population, gross cropped area percent, sugarcane tops, palm press fiber, grains and brans availability, and total available dry matter percent. The rainfall in the regions were negatively correlated with sheep, goat, cultivated fodder, private primary grazing areas, public primary grazing areas, public secondary grazing areas, legume straws, chunnies, and oil seed cakes.

Keywords: Feed resources, livestock, dry matter availability, Chittoor district, Andhra Pradesh

Introduction
The livestock industry contributes to economic growth of developing nations by providing food security and ameliorating nutritional deficiencies. Livestock rearing is a fundamental section of Indian agriculture supporting livelihood of nearly two-thirds of the Indian rural population (Karthik *et al*., 2021) [12]. India is blessed with major draught, milch, and dual-purpose breeds of cattle which are distributed according to the prevailing agroecological zones of the country. Apart from the genetics, feed resources availability plays a vital role in tapping the maximum production potential of livestock and poultry (Ayele *et al*., 2021) [6]. Feeding well-balanced diet aids in the ultimate production goal for attaining high and sustained output.
The inadequate feed resource has been one of the major constraints in India; the country is short of dry fodder by 11%, green fodder by 28%, and concentrate feeds by 35% (NIANP, 2005) [18]. The unavoidable factors such as shift to commercial crops, shrinking of common property resources and shift towards the cultivation of commercial crops are depleting the feed and fodder resources. Although India tops in milk production, the individual productivity is far low compared to other nations. Enhancing the individual productivity in a huge population of low-producing animals is one of the biggest challenges of Indian livestock sector (Thornton, 2010) [31]. In this scenario, scientific efforts for the effective utilization of the available feed resources and strategic approaches for adoption of new technologies are essential (Naik and Singh, 2010) [17]. Quantification of existing feed resources is necessary for the development of

efficient feeding strategies and for the judicious utilization of available feed resources (Ranjhan 1994; Alpha Agritech 1998) [23, 1].

Chittoor district is one of the 13 districts of Andhra Pradesh, situated in the Rayalaseema region, at a latitude and longitude of 13.4788° N and 78.8383° E, respectively. The district takes pride in the country in having famous world-renowned livestock breeds like crossbred Jersey cows, crossbred HF cows, Khillari cattle, Nellore jodipi sheep and most importantly layer and broiler poultry farms at huge scale. The major products contributing to the Gross Value Addition of the region are the products of agriculture and allied services such as sugarcane, groundnut, tomato, mango, milk, and meat. Nevertheless, according to the Indian Ministry of Panchayat Raj, Chittoor district is one of the country's 250 most backward districts and has been continuously receiving funds from the Backward Regions Grant Fund Programme (MPR, 2012). Considering the importance of livestock sector in Chittoor district, the current study is aimed at assessing the animal and feed resource availability within the region to uncover the concealed individual productivity of the crossbred livestock.

Materials and Methods

Study area

The current study area is Chittoor district, which is one of the 13 districts of Andhra Pradesh, situated in the Rayalaseema region, at a latitude and longitude of 13.4788° N and 78.8383° E, respectively (Figure 1).

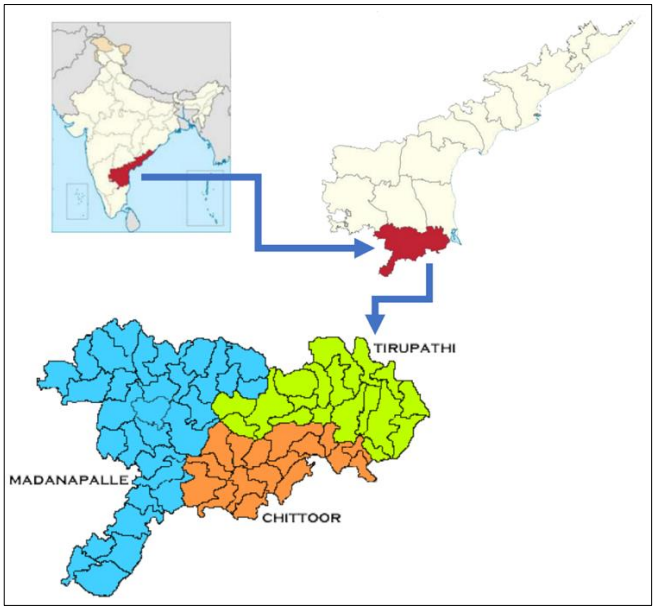


Fig 1: Map showing the study region (Chittoor district with Tirupathi, Madanapalle, and Chittoor divisions)

Secondary data collection

Year wise crop production and land utilization data of the Chittoor district of Andhra Pradesh state was obtained from the Directorate of Economics and Statistics, Government of Pradesh, Hyderabad. The region wise latest livestock census data, 2012 was collected from the Department of Animal Husbandry, Dairying and Fisheries, Government of India (GOI 2012a) [8]. Region wise milk production was obtained from the Animal Husbandry Department, Govt. of A.P (Anon 2009-10) [2]. The entire data of Andhra Pradesh and Telangana regions is used to identify the correlation of rainfall with various livestock and feed resources within the region.

Adopted methodology

The methodology followed in the study was as suggested by Raju *et al*. (2017, 2018) [19-20] and Reddy *et al*. (2018) [19] with slight modifications. Present study used mean values of the last three consecutive years (2010-11, 2011-12 and 2012-13) crop production data instead of one year to reduce the differences in annual variations (Anon 2010-13) [5]. Feed resources were categorized as green forages, crop residues and concentrates (grains, grain byproducts and oil seed cakes). Yields from greens, crop residues and by-products were estimated on the basis of dry matter (DM) yield assuming 25%, 90% and 90% DM, respectively.

Calculation of green fodder availability

Availability of green forages was estimated (ISPA, 1997) as per following classifications and assumptions:

Cultivated fodder: Fodder grown in the area with an average annual yield of 40 tonnes/ha;

Area under Farm bunds: 2.024% of the Gross cropped area, excluding the area under fodder crops with an average annual yield of 5 tonnes/ hectares

Private primary grazing: Consisting of current fallow land and other fallow lands with an average annual yield of 1.0 tonnes/hectares

Public primary grazing: Comprising of permanent pasture, miscellaneous tree crops and cultivated waste with an annual average yield of 1.0 tonnes/ hectares

Public secondary grazing: Consist of forest area and on assumption that only 50% area was accessible for grazing with an annual yield of 3.0 tonnes/hectares

The contribution of Gross cropped area to the total green fodder availability is obtained by adding the yield from cultivated fodder and area under farm bunds. In case of sugarcane tops, a conversion factor (0.25) was used to calculate the quantity of sugar cane tops available for livestock feeding. As Cassava foliage is often used as fodder source in the region, a conversion factor of 5.66 (On DMB) was utilized to predict the total tapioca foliage used as livestock fodder.

Calculation of dry fodder availability

Suitable conversion factors on the basis of grain to straw ratios and extraction rates were used to estimate availability of crop residues, grains, grain-byproducts, and oil seed cakes from crop production data (Raju *et al.* 2002; Anandan *et al.* 2005) [3]. Fine straw included straw from paddy, wheat and Ragi crops; while coarse straw included straw from coarse cereal crops like jowar, bajra, maize and small millets. Legume straw comprises of crop residues produced from pulses and groundnut (Ramachandra *et al*. 2007). Conversion factors employed for estimation of crop residues from paddy, ragi, pulses and groundnut were 1.30, 2.00, 1.70 and 2.00, respectively.

Calculation of concentrate availability

Conversion factors used for estimation of oil cakes from groundnut and coconut were 0.7 and 0.0625, respectively. Conversion factor, 0.02 was used for estimation of grains from paddy and wheat. Availability of brans and chunnies were calculated by utilizing 0.08 and 0.03 as conversion factors from paddy and pulses, respectively. Even-though the production is at higher rate in few districts, due to their

complete usage in starch and sago production, Cassava tubers are not included in the present study as an animal feed resource.

Poultry allocation hypothesis

For the purpose of estimating the feed requirement by the livestock, only the ruminant species and improved poultry, which account for the use of major share of feed resources available, were taken into account. Of the total available concentrates in all the districts around 42% have been allocated to the poultry (CLFMA, 2005). It was assumed that each layer on an average consume about 40 kg feed/year and each broiler would consume 3.2 kg with 5 batches of broilers reared per annum (Narahari *et al*. 2000). The remaining concentrates (58%) in addition to the crop residues and greens are accounted for while estimating the DM availability for the ruminant species.

Ruminant Livestock Unit and Categorization

To eliminate constraints of the wide variations in live weight and production among ruminants (cattle, buffalo, sheep and goat) population, they were converted to the standard Ruminant Livestock Unit (RLU) using conversion factors (Ramachandra *et al.* 2001; Table 1) [22].

Table 1: Conversion factors for calculating Ruminant livestock unit

Species (‘000)	Age/Type	Conversion factor
Cattle (Cross Bred/Exotic) male	< 1.5 yrs age	0.34
	> 1.5 yrs age	1.00
Exotic female	< 1 yrs age	0.11
	1- 2.5 yrs age	0.50
	>2.5 milch	1.14
	> 2.5 non milch	1.00
Indigenous male cattle	< 2 yrs age	0.34
	>2 yrs age	1.00
Indigenous female cattle	< 1 yrs age	0.11
	1- 3 yrs age	0.50
	>3 milch	1.00
	>3 non milch	1.00
Buffalo male	< 2 yrs age	0.50
	>2 yrs age	1.00
Female buffalo	< 1 yrs age	0.17
	1- 3 yrs age	0.50
	>3 milch	1.14
	>3 non milch	1.00
Sheep and Goat	< 1 yrs age	0.03
	> 1 yrs age	0.10

The DM requirement of the individual RLU was estimated @ 2% of BW i.e., 7 kg/day (Anandan and Sampath 2012). Finally, the studied region was categorized as per the estimated DM availability as per the criteria provided in Table 2.

Table 2: Categorization of the studied region as per estimated DM availability

Categories	Criteria
Adequate	>80% DM availability
Moderately adequate	60–79% DM availability
Deficient	40–59% DM availability
Severely deficient	< 40% DM availability

Statistical Analysis

The frequency counts of individual variables were counted using PROC FREQ procedure. Data in tables were presented as mean values, ignoring standard deviation and error. Mean values of the 3-years data were calculated using the AVG function. While calculation, null or missing values were ignored. The correlations among feed or livestock resource-variables and rainfall were analyzed by PROC CORR statement. The *P* values less than 0.05 and 0.01 were considered as significant and denoted by single star (*) and double star (**), respectively. All analyses were performed using the SAS 9.4 (Statistical Analysis System Institute, Inc., Cary, NC, USA).

Results and Discussion

Livestock resources

The data on composition and distribution of livestock species in the Chittoor region was presented in Table 3 and Figure 2.

Table 3: Livestock and poultry population (‘000) in Chittoor district of Andhra Pradesh

Species	Population (‘000)
Total Cattle	927
Cross Bred/Exotic Cattle	731
Indigenous Cattle	195
Buffalo	84
Sheep	1250
Goat	429
Pigs	8
RLU	885
Layers	4844
Broilers (5 Batches)	32290

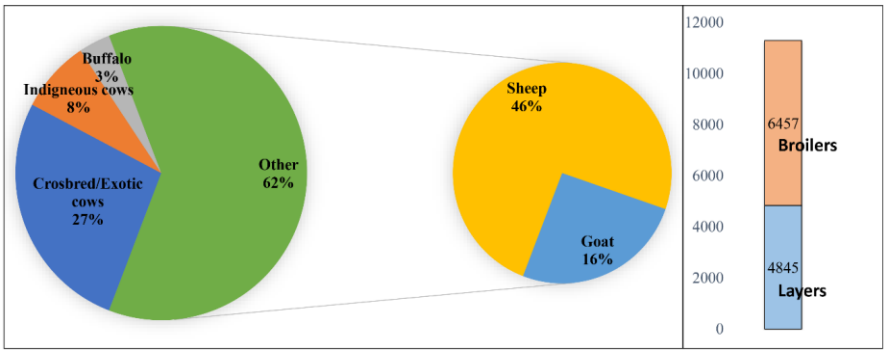


Fig 2: Livestock share of the Chittoor district

Cattle, buffaloes, sheep, goats, and pigs account for 34.36%, 3.11%, 46.33%, 15.90%, and 0.30%, respectively, of the total region's population of various livestock species. About 43% of the entire Rayalaseema region's cattle population is present in Chittoor district. Due to the enormous amount of crossbred cattle population, Palamaner area in the Chittoor district is often called as Milk city of South India. Earlier meteorological recordings revealed lower relative humidity, dry-bulb temperature, temperature-humidity index within the studied region (Karthik *et al*., 2021a, b) [12-13]. These low recordings are known to much suite the optimum conditions for the growth and sustainability of crossbreed cattle (Stone *et al*., 2017). Chittoor district alone contributes about 91% of total Broilers and 87% of total Layers population in the Rayalseema region. Unlike the other districts of the Rayalseema region, majority mandals in Chittoor district possesses moderate to cooler climate, which may be the reason for attracting a higher proportion of poultry farmers. Besides, due to the geographical contiguity with Tamil Nadu and Karnataka states, the district holds huge poultry market potentiality.

Among the cattle population, 77.14% of the cattle in the region are crossbred, while the remaining 22.86% belongs to Indigenous category. Within the meager Indigenous cattle breeds, the major proportion will be in and around the villages of Bakhrapeta forest area. Rearing of sheep is more prominent in the district with 46% of the total livestock population whereas goat production is practiced on a small scale compared to sheep (16%). In the region, the share of rainfed area in the net sown area accounts for nearly 70% (Kumar and Subramanyachary, 2015). Similar to the report by Ramachandra *et al*. (2007) and Reddy *et al*. (2018) [19], rain fed ecosystems (substantial portion of Krishna and North Costal Zones) harbor a higher proportion of sheep population.

Feed resources

The mean values of land utilization pattern and potential feed availability from different feed resources are presented in Table 4 and 5, respectively. Considering the feed resource availability, the region possesses overall DM availability of 1.77 million tonnes for both livestock and poultry.

Table 4: Mean values of land utilization pattern ('000 ha) in Chittoor district of Andhra Pradesh

Land Utilization Pattern	Hectares ('000)
Gross cropped area	416
Fallow land	244
Permanent pasture land	34
Miscellaneous tree crops	30
Cultivable waste land	46
Forest area	452
Forest area (% of geographical area)	34

Table 5: Potential feed availability ('000 tonnes) from different feed resources in Chittoor district of Andhra Pradesh

Feed resource	Tonnes ('000)
Cultivated fodder	1037
Forage under farm bunds	41
Private primary grazing	244
Public primary grazing	110
Public secondary grazing	678
Sugarcane tops	13.52
Tapioca foliage	0
Total greens	2124
Total greens (DMB)	531
Total Crop Residue	1256
Fine straw	245
Coarse straw	35
Legume straw	309
Sugarcane crop residues	667
Palm Press fiber	0
Total C. Residue (DMB)	1130
Grains	5
Brans and chunnies	14.22
Oil seed cakes	105
Total DMB concentrates	112
Broilers (5 batches)	103
Layers	194
Total concentrates DMB	267

Green Forage

Green forage contributed nearly one-tenth (29.95%) to the total DM availability of the region. With regard to green forage DM availability, main portion of greens is contributed from the forest area followed by gross cropped area. However, various scenarios identified the highest contribution of gross cropped area to green forages at national level (Ramachandra *et al*. 2007), Andhra Pradesh (Raju *et al*., 2017; Reddy *et al*., 2018) [19], Telangana (Raju *et al*., 2018) [20], and Karnataka (Anandan *et al*. 2004) [2] levels. The higher contribution from forest area could be due to the presence of forest land at huge proportion (34%) in the district. Chittoor region is having Eastern ghats' rich vegetational belt, that harbors primarily tropical deciduous vegetation. As per the Champion and Seth's (1968) classification, the forest types found in the region are Tropical Moist Mixed Deciduous Forests, Tropical Dry Deciduous Scrub Forests and Tropical Dry Evergreen Scrub Forests. Nonetheless, it is noteworthy that the forest cover of the district is a bit-higher than the recommended 33% as per the National's Forest policy (Anon, 2011) [4].

The contribution of greens from the cultivated fodders to the total green forage's availability is 48.82%. Super Napier, Co-3, Co-4, para grass, cow pea, pillipesara and crotalaria were the major fodder crops grown in the region. Among the grazing resources, public secondary grazing resources occupied a lion's share followed by private primary grazing resources. This phenomenon is due to the low area under fallow lands. Looking in to the shrinkage of community grazing lands at village level annually, very little scope exists for enhancing the availability of green roughages through this resource. In spite of this, with suitable interventions like introduction of appropriate short duration varieties of grasses, a major chunk of fallow lands (both current and other fallows) can be exploited for increasing the green fodder availability from private primary grazing areas (Raju *et al*. 2002). Sugar cane tops also contribute little quantity of greens and are cultivated predominantly in Chittoor region.

Major emphasis should be given for the development of legume fodder in the region if further growth has to be realized in livestock sector. Suitable interventions need to be made to increase yield of green forage quantitatively and qualitatively. The gradual reduction of grazing lands, common property sources, stagnation of area under fodder crops at almost 4% of gross cropped area and stringent grazing policies are resulting in the expanding of gap in supply and requirement of green fodder (Reddy *et al*., 2018) [20].

Dry Forage

The availability of crop residues ('000 tonnes) in Chittoor district is presented in Table 6. The availability of dry matter as dry fodder or crop residues is 3.47 Mt. Interestingly, sugarcane crop residues contributed to 59% of the total crop residue-based DM supply for livestock with in the region. On contrary, several studies observed cereal straws major crop residues at national (Ramachandra *et al*. 2007), Andhra Pradesh (Raju *et al*., 2017; Reddy *et al*., 2018) [19], Telangana (Raju *et al*., 2018) [20], and Karnataka (Anandan *et al*. 2004) [2] levels. Unlike majority of the regions with routine cereal crops, Chittoor district is unique in growing Sugarcane, an important cash crop of India. An earlier case study with 60 respondents of Aggichenupalli village of Chittoor district revealed that the huge proportion of farmers of the region are interested in Sugarcane farming because of the better economic benefits associated with Sugar preparation and Jaggery making. They also mentioned the advantage of having sugar industries with in the district at numerous locations.

Table 6: Availability of crop residues ('000 tonnes) in Chittoor district of Andhra Pradesh

Crop residue	Quantity ('000 tonnes)
Paddy straw	228
Sorghum straw	1
Bajra straw	10.4
0Maize straw	23
Ragi straw	18
Small millet straw	0.3
Horse gram straw	5.58
Green gram straw	0.706
Black gram straw	2.5
Red gram straw	2
Bengal gram straw	0.008
Cow gram straw	0.6
Ground nut straw	297
Soyabean straw	0.0107
Sugar cane	667

Within the available crop residues, the kind of straw available exerts a profound effect on the nutrient availability. While calculating the types of crop residues (excluding sugarcane residues), the data revealed paddy straw representing almost 2.28 Mt i.e., 38.7% of total crop residues. Paddy is followed by Maize (0.23 Mt), ragi (0.18 Mt), and Bajra (0.104 Mt) straws. In India, cereal cultivation is practiced at larger sector resulting in production of beverage byproducts at higher amounts (Lakshmi *et al*., 2017; Reddy *et al*., 2017) [19]. The byproducts include, corn germ meal, dried distillers grains with solubles, condensed solubles, and maize spent liquor. However, predominance of nutritionally poor cereal straws su000ggests that the efficiency of such production system is quite low.

Among the leguminous straws, groundnut straw contributed to the largest extent (50.42%), followed by horse gram (0.95%), black gram (0.42%), and red gram (0.34%) straws. Although the presence of ground nut straw is huge, the contribution of cereal straws is not at a dispensable proportion. These cereal straws are very poor in digestible nutrients and they have to be supplemented with concentrates or other protein rich legumes or non- protein nitrogen compounds like urea etc. to improve their nutritive value. Mixing cereal straws with legume straws in 3:1 proportion is a sensible option to meet nutrient requirements and enhance the production status. Furthermore, enriching the poor-quality cereal straws with urea is a viable option for sheep (Reddy *et al*., 2019a) [26], cattle (Salami *et al*., 2021) [30], and buffaloes (Reddy *et al*., 2019b) [21].

Potential DM available from crop residues was higher than DM available from green forages, which was similar to situation of national (Ranjhan 1994) [23], Andhra Pradesh (Raju *et al*., 2017; Reddy *et al*., 2018) [19], Telangana (Raju *et al*., 2018) [20], and Karnataka (Biradar and Kumar 2013) [7] level. As reported by the Rao and Hall 2003, the mixed crop–livestock systems of India are underpinned by the crop residues, which contribute on an average 40–60% of the total dry matter intake per livestock unit. There is however a considerable regional variation in the dominant type of crop

residue *viz*. rice and wheat straws in irrigated regions compared to coarse cereal straws and hay from leguminous crops in the drier, semi-arid regions. Similarly, paddy and maize straw availability is high in irrigated areas of the region and coarse cereal straw like sorghum is more in rain fed and less irrigated parts of the region.

Concentrates

District wise availability of concentrate ingredients (‘000 tonnes) in the region under study was presented in Table 7. The total concentrates required for poultry (166.294 million birds) was 0.408 Mt but the total availability itself was 0.124 Mt only, which suggested that the region was not self-sufficient in feed resources to take care of the feed requirement of its poultry population, even if all concentrates would be allocated to them. The growth of poultry industry at an exuberant rate in the region could be attributed to the developmental activities taken up the APMPDC (Andhra Pradesh State Meat and Poultry Development Corporation), 1977. Major feed ingredients in poultry feed formulations are maize and soybean meal. Compared to Maize, soya bean produced in the region was very less and insufficient to meet the requirement and so, they are procured from the neighboring states like Madhya Pradesh and Maharashtra, which contributes to 89% of the total country’s soya production (Hazra *et al*. 2015).

Table 7: Availability of concentrate ingredients (‘000 tonnes) in Chittoor district of Andhra Pradesh

Concentrate	Quantity (‘000 tonnes)
Rice bran	14.013
Sorghum grain	0.016
Bajra grain	0.208
Maize grain	0.934
Ragi grain	0.442
Millets grain	0.012
Cotton seed cake	0.007
Ground nut cake	89.233
Gingelly cake	0.106
Sunflower cake	0.462
Coconut cake	1.088
Rape and mustard cake	0.0087
Soya bean meal	0.0048
Castor cake	0.0403
Linseed meal	0.00044
Broken Rice grain	3.503
Pulse Chunnies	0.219
Palm kernel cake	0.063
Miscellaneous oil seed cakes	14

Of the available concentrate ingredients in the region, grains, brans and chunnies, and oilseeds account for 4.03%, 11.45%, and 84.53%, respectively. Similarly, Ravikiran *et al*. (2012) reported a higher portion of oilseed cakes followed by brans & chunnies and grains at national level. Exactly opposite patterns were reported earlier (Karthik *et al*., 2020) [14]. The oil seed cakes owes to the higher proportion of groundnut cultivation, accounting for a lion share of the total accessible concentrates in the region. The major portion of the district is covered by red soils with portions of alluvial soils, which are most suited for groundnut cultivation.

The data related to the potential feed requirement and availability for ruminants in Chittoor district are presented in Table 8.

Table 8: Potential feed requirement and availability for ruminants in Chittoor district of Andhra Pradesh

Feed Requirement	
RLU (‘000)	891
Requirement (‘000 tonnes)	
Total DM	2277
Green fodder	2547
Dry fodder	1415
Concentrates	408
Availability for ruminants (‘000 tonnes)	
Total DM	1659
Green fodder	2124
Dry fodder	1254
Concentrates DM	0 (-155)
Total Availability for livestock and poultry (‘000 tonnes)	
Total DM	1771
Green fodder	2124
Dry fodder	1254
Concentrates	124
Availability (%)	
Total DM	72.86
Green fodder	83.39
Dry fodder	86.62
Concentrates	0

It should be observed that the contribution of all other sources except green forages is influenced primarily by crops grown in the region as well as the prevailed cropping intensity. In addition to these production aspects, various social and economic aspects like land, crop, and animal ownership patterns, cultural practices, the use of advanced crop varieties and the opportunities for market and nonmarket exchanges also influenced. Hence, the export from other states is significant (Biradar and Kumar 2013) [7]. It may not be obligatory that one ingredient available in particular region is essentially utilized by livestock in the same state. This is valid for any feed resource but is more common for concentrate ingredients (Ramachandra *et al*. 2007). Although there is interstate or inter district movement of feed resources, there is a little information available in this aspect. In this study, it has been assumed that feed resources produced in a specific agro-ecological region are potentially available for consumption by the livestock within the region or district (Ramachandra *et al*. 2007).

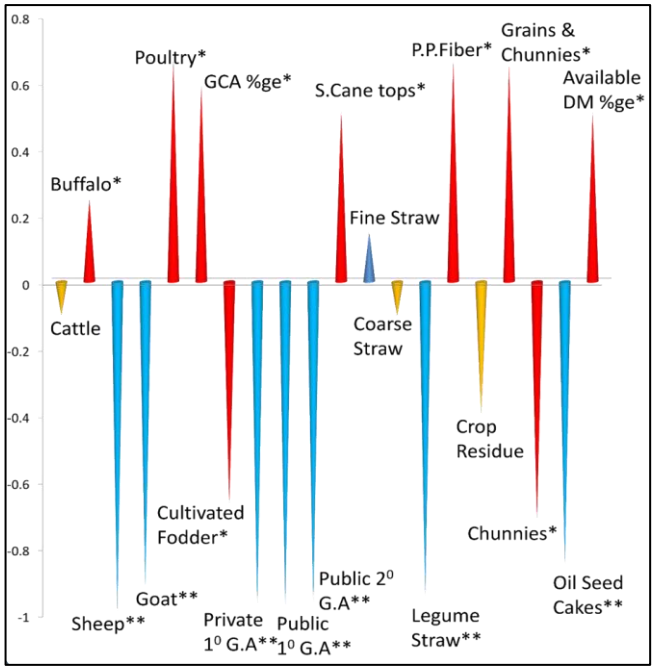
Contribution of different sources towards total estimated DM availability is presented in Tables 9. The availability of green forages, dry forages, and concentrates is 31.96%, 68.04%, and 0% respectively. Although the region is self-sufficient in terms of green and dry forages, it is facing a severe scarcity of concentrates. Exploitation of the non-conventional feed resources in livestock production systems is considered to be the best substitute to combat the concentrate scarcity (Reddy *et al*., 2019a, 2019b) [26-27].

Table 9: Contribution of different sources towards total estimated DM availability in Chittoor district of Andhra Pradesh

Availability and Requirement	Million tonnes
ACU	891227
Green forages	1.63
Dry forages	3.47
Concentrates	0.00
Total DM availability	5.10
DM Requirement	7.00
Surplus/ Deficit	-1.90
% DM Availability	72.88

Correlation of crops and livestock species within Andhra Pradesh and Telangana regions

The data pertaining to Andhra Pradesh (Raju *et al*., 2017; Reddy *et al*., 2018) [19] and Telangana regions (Raju *et al*., 2018) [20] are used to identify the correlation between rainfall and various feed and livestock resources within those regions (Figure 3).



*P<0.05; **P<0.001

Fig 3: Correlation coefficients of various feed resource-related parameters with annual rainfall

The rainfall was positively correlated to the buffalo and poultry population and negatively correlated to sheep and goat population. Humid and high rainfall conditions favor the buffalo population compared to crossbred cows, which are more subjected to climatic stress and diseases. Moreover, the resourceful and paddy cultivation areas attract buffalo population (Vandeplas and Squicciarini 2010). With in the ruminant species, small ruminants (sheep and goat), especially goat are more resistant to heat stress. Further, because of the peculiar browsing and grazing habits of goats and sheep, those species thrive under the arid environmental conditions with limited fodder supply (Reddy *et al*., 2019c, Hyder *et al*., 2017a,b) [28].

As anticipated, the rainfall conditions were positively correlated to the gross cropped area percent and sugarcane tops, grains, and total available dry matter percentage, which in turn depends upon the earlier mentioned feed resources. Similar results were reported elsewhere (Raju *et al*., 2017, Reddy *et al*., 2018) [17]. Interestingly, the cultivated fodder sources is negatively correlated to the rainfall zones, which might be due to the government initiatives or schemes to increase fodder production within the low rainfall zones of Andhra Pradesh. Furthermore, the rainfall is inversely correlated to the private primary grazing areas, public primary grazing areas, and public secondary grazing areas. Legume straws and oil seed cakes are more available in low rainfall zones compared to surplus rainfall zones. This fact might be due to the interest of non-arid regions' farmers in cultivating the commercial crops such as sugarcane, tapioca, and palm oil plantations. For instance, most of the Godavari farmers are growing palm and tapioca and Chittoor farmers are interested in cultivating Sugarcane. In the same connection, the prevalent arid region of Andhra Pradesh (Anantapur district) is a world-recognized groundnut cultivating area. Nonetheless, the region sampled is may not be adequate to find the correlations of rainfall. The research area has future scope in correct estimations using large data sets of entire country.

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Conclusion

Regardless of the abundant dry matter accessibility, an inconceivable gap exists between the demand and supply of concentrate feed ingredients for both poultry and milch animals in the region. Therefore, there is a strong urge for the efficient usage of agro-industrial byproducts and/or non-conventional feed resources available in the region, for the successful livestock and poultry sustainability. The region is self-sufficient in terms of dry forage availability though majority of dry forages are nutritionally poor cereal straws. Hence, suitable strategies should be developed for the efficient utilization of existing feed and fodder resources to improve animal productivity in this state.

References

1. Alpha Agritech. Survey of Fodder and Feed Resources in Karnataka State. Report submitted to Department of Animal Husbandry and Veterinary Services, Government of Karnataka. 1998;5:2.
2. Anandan S, Raju SS, Angadi UB, Ramachandra KS. Regional variation in the availability of feed resources in Karnataka state: A case study. In: Proceedings of X Animal Nutrition Society of India Conference, Jabalpur, India. 2004 January 5-7, 23-24.
3. Anonymous. Integrated Sample Survey, Animal Husbandry Department, Govt. of A.P., Shanti Nagar, Hyderabad – 500028, 2009-10.
4. Anonymous. Forestry Facts and Figures. Govt. of AP. Forest Department. Andhra Pradesh, Hyderabad – 500 004, India, 2011.
5. Anonymous. Season and crop report of Telangana. Directorate of economics & statistics, Government of Telangana. 2011-12, 2012-13, 2013-2014
6. Ayele J, Tolemariam T, Beyene A, Tadese DA, Tamiru M. Assessment of livestock feed supply and demand

concerning livestock productivity in Lalo Kile district of Kellem Wollega Zone, Western Ethiopia. Heliyon. 2021;7(10):e08177.
7. Biradar N, Kumar V. Analysis of fodder status in Karnataka. The Indian Journal of Animal Sciences. 2013;83(10):1078-1083.
8. GOI (Government of India). District wise livestock census data - 2012. Department of animal husbandry and dairying & fisheries, Government of India, 2012a.
9. GOI. Report of the working group on animal husbandry & dairying 12th five year plan (2012-17). Submitted To Planning Commission Government of India New Delhi, 2012b, 17p.
10. Hyder I, Pasumarti M, Reddy PRK *et al*. Thermotolerance in domestic ruminants: a HSP70 perspective. In: Asea A, Kaur P (eds) Heat shock proteins in veterinary medicine and sciences. Heat shock proteins, Springer, Cham, 2017b, 12. https://doi.org/10.1007/978-3-319-73377-7_1
11. Hyder I, Reddy PRK, Raju J *et al*. Alteration in rumen functions and diet digestibility during heat stress in sheep. In: Sejian V, Bhatta R, Gaughan J, Malik P, Naqvi S, Lal R (eds) Sheep production adapting to climate change. Springer, Singapore, 2017a. https://doi.org/10.1007/978-981-10-4714-5_11
12. Karthik D, Suresh J, Reddy YR, Sharma GRK, Ramana JV, Gangaraju G. Farming systems in sheep rearing: Impact on growth and reproductive performance, nutrient digestibility, disease incidence and heat stress indices. PLoS ONE 2021a;16(1):e0244922. https://doi.org/10.1371/journal.pone.0244922
13. Karthik D, Suresh J, Reddy YR, Sharma GRK, Ramana JV, Gangaraju G. Adaptive profiles of Nellore sheep with reference to farming system and season: physiological, hemato-biochemical, hormonal, oxidative-enzymatic and reproductive standpoint. Heliyon. 2021b;26;7(5):e07117. doi: 10.1016/j.heliyon.2021.e07117
14. Karthik D, Reddy YPK, Gangaraju J, Suresh G, Praneeth DV. An Insight into the Sustainability of Livestock Farming with Respect to Feed Resource Availability in a Microcosmic Land: A Case Study of Nellore District, India. International Journal of Current Microbiology and Applied Science. 2020;9(3):2243-2255.
15. Lakshmi RK, Kumari K, Reddy P. Corn Germ Meal (CGM) - Potential Feed Ingredient for Livestock and Poultry in India- A Review. International Journal of Livestock Research. 2017;7(8):39-50. http://dx.doi.org/10.5455/ijlr.20170527064515
16. MPR. Ministry of Panchayati Raj (8 September 2009). "A Note on the Backward Regions Grant Fund Programme" (PDF). National Institute of Rural Development. Archived from the original (PDF) on 5 April 2012. Retrieved 27 September, 2011.
17. Naik PK, Singh NP. Nutritional interventions for sustainable dairy production in Goa. Souvenir & Concept Papers of State Level Workshop for Veterinary Officers and Progressive Dairy Farmers, Souvenir & Concept Papers No 12. ICAR Research Complex for Goa, Old Goa, India, 2010, 1-114p.
18. NIANP - National Institute of Animal Nutrition and Physiology, Bangalore, India, 100p.
19. Raju J, Reddy P, Reddy A, Kumar C, Hyder I. Livestock feed resources in surplus rainfall Agro-ecological zones of Andhra Pradesh: Requirement, availability and their management. International Journal of Livestock Research. 2017;7(2):148-163. doi:10.5455/ijlr.20170209071714
20. Raju J, Reddy PRK, Kumari NN, Narasimha J, Nagalakshmi D. Assessment of potential livestock feed resources in Telangana State, India. Indian Journal of Animal Research. 2018;52(8):1285-1291. Doi: 10.18805/ijar.B-3361
21. Raju SS, Anandan S, Angadi UB, Ananthram K, Prasad CS, Ramachandra KS. Assessment of animal feed resources availability in Southern Karnataka region. Indian Journal of Animal Sciences. 2002;72(2):1059-1063.
22. Ramachandra KS, Anandan S, Raju SS. Livestock feed resources availability in India and need for a national data base. In: Proceedings of X Animal Nutrition Conference on Emerging Nutritional Technologies for Sustainable Animal Production and Environmental Protection, November 09-11, 2001, Karnal, India, 2001, 134-144p.
23. Ranjhan SK. Consultant's Report on Availability and Requirement of Feed and Fodder for Livestock and Poultry. Department of Animal Husbandry and Dairying. Ministry of Agriculture, Government of India, New Delhi, India, 1994, 101-108.
24. Rao PP, Hall AJ. Importance of crop residues in crop–livestock systems in India and farmers' perceptions of fodder quality in coarse cereals. Field Crops Research. 2003;84:189-198.
25. Reddy PRK, Kumar BR, Prasad CS. Erythrocyte fragility-based assessment of true thermal resilience in tropical small ruminants. Biological Rhythm Research 2019c, 234-345. https://doi.org/10.1080/09291016.2019.1629087
26. Reddy PRK, Kumar DS, Rao ER, Seshiah VC, Sateesh K, Rao KA. Environmental sustainability assessment of tropical dairy buffalo farming vis-a-vis sustainable feed replacement strategy. Scientific Reports. 2019a;9:16745. https://doi.org/10.1038/s41598-019-53378-w
27. Reddy PRK, Kumar DS, Rao ER, Seshiah VC, Sateesh K, Reddy YP. Assessment of eco-sustainability vis-à-vis zoo-technical attributes of soybean meal (SBM) replacement with varying levels of coated urea in Nellore sheep (*Ovis aries*). PLoS One. 2019b;14:e0220252. https://doi.org/10.1371/journal.pone.0220252.
28. Reddy PRK, Lakshmi R, Raju J, Kishore K, Kumar C. CNCPS Fractionations and in-vitro nutrient digestibility of corn dried distiller grains with Solubles from various ethanol plants in Andhra Pradesh. International Journal of Livestock Research. 2017;7(2):164-171. doi: http://dx.doi.org/10.5455/ijlr.20170209071816
29. Reddy PRK, Raju J, Reddy AN, Kumar DS, Lakshmi RKS, Hyder I. Assessment of Feed Resources Availability for Livestock in the Semi-Arid Region of Andhra Pradesh, India. Indian Journal of Animal Nutrition. 2018;35(1):59-65. Doi: 10.5958/2231-6744.2018.00007.5
30. Salami SA, Moran CA, Warren HE, Taylor-Pickard J. Meta-analysis and sustainability of feeding slow-release urea in dairy production. PLoS ONE. 2021;16(2):e0246922. https://doi.org/10.1371/journal.pone.0246922
31. Thornton PK. Livestock production: recent trends, future prospects. Philos Trans R Soc Lond B Biol Sci. 2010;365(1554):2853-2867.