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Case Study

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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

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A B S T R A C T

An assessment of Livestock and poultry feed resource availability was done based on secondary data inNellore district of AndhraPradesh state. Among the large ruminants, buffalo population was highest compared to total cattle population. Sheep outnumbered goats with 3:1 ratio. Similarly, the total population of broilers was higher than layers with 2:1 ratio. The region possess overall DM availability of 7.61 million tonnes (Mt) from various feed resources. Major portion (44.3%) of the green DM forage availability is contributed from the gross cropped area in the district followed by forest area. Crop residues contributed to 88.5% of total DM supply for livestock in the region. Straw from paddy and maize followed by sugarcane crop are the major cereal straws available in the region. The contribution of the concentrates towards the overall DM availability of the region is 6.31%. The DM availability per RLU/day for the region as a whole is 7.61 kg. The study revealed that there was a surplus DM in Nellore district (108.75). The percentage availability of dry matter, green forages, dry forages, and concentrates per RLU for the region are 108.75, 37.76, 158.4, and 49.6, respectively. Scarce concentrate availability 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 livestock and poultry. Although the region is self-sufficient in terms of dry forage availability, 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 region.

Introduction

Animal husbandry is an integral component of Indian agriculture supporting livelihood for more than two-thirds of the Indian rural population. India has been house to major draught, milch and dual-purpose breeds of cattle which are distributed across different states of the country. Feed availability is the major constraint to realize high productivity from livestock and poultry in any country or state as feed cost accounts for about 75% of the total cost of production (Naik *et al.*, 2012). Adequate supply of quality feed and fodders is critical for enhancing productivity of dairy animals. However, 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). The feed and fodder resources are gradually decreasing throughout India owing to many factors like shrinkage of common property resources and shift towards the cultivation of commercial crops etc. (Biradar and Kumar 2013). But, the average milk and meat yield of Indian livestock is much lower than the world average. Enhancing productivity in a huge population of low-producing animals is one of the biggest challenges of Indian livestock sector (GOI2012b). 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). 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).

Nellore district is one of the 13 districts of Andhra Pradesh, situated on the south-eastern coast of the state, at a latitude and longitude of 14.2581° N and 79.9193° E, respectively. The district is blessed with highly valuable livestock resources, accounting for 5.85% of the entire country's livestock population. The district takes pride in the country in having famous world renowned Livestock breeds like Ongole cattle, graded Murrah buffaloes, Nellore sheep and Aseel poultry birds. Per capita income both from the agriculture and non-agriculture sectors is highest in Nellore district, which indicates that agricultural income has complemented non-agricultural income in the region. The region has benefitted a lot from productivity enhancing technology in the 'green revolution' period (Reddy and Bantilan) and is the largest paddy cultivating district after Krishna-Godavari twin delta region.

The current study focuses on the assessment of animal and feed resource availability in Nellore district, which is relatively surplus in annual rainfall as compared to the remaining dry zones with in the state of Andhra Pradesh.

Materials and Methods

Year wise crop production and land utilization data of the Nellore 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 & Fisheries, Government of India (GOI 2012a).Region wise milk production was obtained from the Animal Husbandry Department, Govt. of A.P (Anon 2009-10).

The methodology followed in the study was as suggested by Raju *et al.*, (2018), Anandan and Sampath (2012) 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).Feed resources were categorized as green forages, crop residues and concentrates (grains, grain by products and oil seed cakes).

Availability of green forages was estimated (ISPA, 1997) as per following classifications and assumptions: (i)Cultivated fodder: Fodder grown in the area with an average annual yield of 40 tonnes/ha; (ii) 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/ha; (iii) Private primary grazing: Consisting of current fallow land and other fallow lands with an average annual yield of 1.0 tonnes/ha; (iv) Public primary grazing: Comprising of permanent pasture, miscellaneous tree crops and cultivated waste with an annual average yield of 1.0 tonnes/ha; (iv) 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/ha. 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.

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).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. 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. 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.

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.

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). The DM requirement of the individual RLU was estimated @ 2% of BW i.e.7 kg/day (Anandan and Sampath 2012).

Results and Discussion

Livestock resources

The data on composition and distribution of livestock species in various districts of the region was presented in Table 2. Cattle, buffaloes, sheep, goats, and pigs account for 5.4%, 29%, 49%, 16.4%, and 0.2%, respectively, of the total region's population of various livestock species. As dairying in entire costal Andhra region is buffalo based due to the consumer preference in favor of buffalo milk, farmers are more interested in rearing buffaloes rather than cattle, which resulted in almost double buffalo population compared to the cattle. Indeed, the really humid climate characterizing the region is more suitable for buffaloes than for crossbred cows which are more subjected to climatic stress and diseases. Moreover, the resourceful and paddy cultivation areas like Krishna and Godavari zones are richer in terms of buffalo population (Vandeplas and Squicciarini 2010).

Among the cattle population, 90.5% of the cattle in the region are Indigenous, while the remaining9.5% belongs to crossbred category. Rearing of sheep is more prominent in the district with 49% of the total livestock population whereas goat production is practiced on a small scale compared to sheep. In the region, the share of rainfed area in the net sown area accounts for nearly 60%. Similar to the report by Ramachandra *et al.*, (2007) and Reddy *et al.*, (2018), rain fed ecosystems (substantial portion of Krishna and North Costal Zones) harbor a higher proportion of sheep population.

Feed resources

Considering the feed resource availability (Table 4) the region possesses overall DM availability of 7.61 million tonnes (Mt) from various feed resources. Mean values of land utilization pattern in region was presented in Table 3. The Potential feed availability ('000 tonnes) from different resources in Nellore district of Andhra Pradesh is presented in Table 5.

Green Forage

Green forage contributed nearly one-tenth (9.93%) to the total DM availability of the region. With regard to green forage DM availability, main portion of greens is contributed from the GCA (45.16%), similar to the scenario at national national (Ramachandra *et al.*, 2007), Andhra Pradesh (Raju *et al.*, 2017; Reddy *et al.*, 2018), Telangana (Raju *et al.*, 2018), and Karnataka (Anandan *et al.*, 2004) level. Jowar fodder, Maize fodder, Napier grass, para grass, pillipesara and jute are the major fodder crops grown in the region (Anon 2010 - 13).The contribution of greens from the public primary grazing areas to the total greens availability is 21.09%. Among the grazing resources, public secondary grazing resources occupied a lion's share with private primary grazing resources contributing least.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).

The contribution of green forage from public secondary grazing resource is as important as that of Gross cropped area, and the former accounts for45.15% of the total green forage

availability. Northern Nellore regions 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. However, the total geographical area of the region under forest cover is 9.12% (Anon 2011), lower when compared to the recommended 33% as per the National's forest policy. Sugar cane tops also contribute little quantity of greens and are cultivated predominantly in Nellore region.

Major emphasis should be given for the development of 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.

Dry Forage

The availability of dry matter as dry fodder or crop residues is 6.37Mt. Crop residues contributed to 83.71% of total cereal straw based DM supply for livestock in the region. These findings are in agreement with reports at national (Ramachandra *et al.,* 2007), Andhra Pradesh (Raju *et al.,* 2017; Reddy *et al.,* 2018), Telangana (Raju *et al.,* 2018), and Karnataka (Anandan *et al.,* 2004) level. However, even within the crop residues the kind of straw available exerts a profound effect on the nutrient availability. Of the total available dry matter from crop residues, paddy straw represents almost 13.27 Mt(Table 6) i.e., 97.12% of total crop residues. Paddy is followed by maize (0.21 Mt), sorghum (0.12 Mt), Bajra (0.06 Mt), and Ragi (0.003 Mt) straws. In India, cereal cultivation is practiced at larger sector resulting in production of beverage by products at higher amounts (Lakshmi *et al.,* 2017; Reddy *et al.,* 2017). The byproducts include, corn germ meal, dried distillers grains with solubles, condensed solubles, and maize spent liquor. However, predominance of nutritionally poor cereal straws suggests that the efficiency of such production system is quite low. Although, ragi straw was nutritionally superior to paddy straw, its availability was meager in the Nellore regions similar to the remaining regions of the Andhra Pradseh and Telangana regions (Raju *et al.,* 2017; Reddy *et al.,* 2018; Raju *et al.,* 2018).

Among the leguminous straws, groundnut straw contributed to the largest extent, followed by Black gram, Bengal gram, and Green gram straws. Amidst of the crop residues majority are cereal straws only (78.86%).Further, paddy straw alone contributes 76.61% of the total crop residue availability in the region. 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. Legume straws account forbarely7.44% of total crop residues.

Potential DM available from crop residues was higher than DM available from green forages, which was similar to situation of national (Ranjhan 1994), Andhra Pradesh (Raju *et al.,* 2017; Reddy *et al.,* 2018), Telangana (Raju *et al.,* 2018), and Karnataka (Biradar and Kumar 2013) 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 inrain 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 (65.9 million birds) was0.262Mt but the total availability itself was0.14Mt 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 Madhyapradesh and Maharashtra, which contributes to 89% of the total country’s soya production (Hazra *et al.*, 2015).

Of the available concentrate ingredients in the region, grains, brans & chunnies, and oilseeds account for 59%, 15%, and 26% respectively. On the contrary, Ravikiran *et al.*, (2012) reported a higher portion oilseed cakes followed by brans & chunnies and grains at national level. The higher brans & chunnies portion owes to the higher rice bran availability, accounting for 59% of the total accessible concentrates in the region.

Rice bran (0.82 Mt) and Broken rice grain (0.20Mt)are the major concentrate ingredients available in the region. The presence of black cotton soils at lower levels extends the Nellore district to have a meager area under cotton cultivation. Furthermore, the climate conditions and red earths in the Nellore district are more favorable for growing oil seed crops, especially groundnut, sunflower, gingelly, soybean and castor crops.

However, 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). Contribution of different sources towards total estimated DM availability and classification of regions as per estimated DM availability are presented in Tables 8 and 9, respectively.

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).

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 & Goat	< 1 yrs age	0.03
	> 1 yrs age	0.10

Table.2 Livestock and poultry population (‘000) in Nellore district of Andhra Pradesh

Species	Population (‘000
Total Cattle	116
Cross Bred/Exotic Cattle	11
Indigenous Cattle	105
Buffalo	624
Sheep	1052
Goat	351
Pigs	5.3
RLU	638
Layers	214
Broilers	445

Table.3 Mean values of land utilization pattern (‘000 ha) in Nellore district of Andhra Pradesh

Land Utilization Pattern	Hectares (‘000)
Gross cropped area	443
Fallow land	119
Permanent pasture land	58
Miscellaneous tree crops	15
Cultivable waste land	83
Forest area	263
Forest area (% of geographical area)	19.26

Table.4 Potential feed availability (‘000 tonnes) from different resources in Nellore district of Andhra Pradesh

Feed Source	Tonnes (‘000)
Cultivated fodder	25
Forage under farm bunds	45
Private primary grazing	119
Public primary grazing	157
Public secondary grazing	394
Sugarcane tops	4.16
Tapioca foliage	0.03
Total greens	744
Total greens (DMB)	186
Total Crop Residue	1733
Fine straw	1328
Coarse straw	39
Legume straw	130
Sugarcane crop residues	230
Palm Press fiber	6
Total C.Residue (DMB)	1560
Grains	22
Brans and chunnies	83
Oil seed cakes	36
Total DMB concentrates	127
Broilers (5 batches)	1.4
Layers	8.6
Total concentrates DMB	9

Table.5 Potential feed requirement and availability for ruminants in Nellore district of Andhra Pradesh

Feed Requirement	
RLU(‘000)	671
Requirement (‘000 tonnes)	
Total DM	1713
Greenfodder	1970
Dry fodder	1094
Concentrates	262
Availability for ruminants (‘000 tonnes)	
Total DM	1863
Green fodder	744
Dry fodder	1733
Concentrates DM	130
Total Availability for livestock and poultry (‘000	
Total DM	1872
Green fodder	744
Dry fodder	1733
Concentrates	140
Availability (%)	
Total DM	108.75
Green fodder	37.76
Dry fodder	158.4
Concentrates	49.6

Table.6 Availability of crop residues (‘000 tonnes) in Nellore districtof Andhra Pradesh

Crop residue	Tonnes (‘000)
Paddy straw	1327
Wheat straw	0
Sorghum straw	12
Bajra straw	6
Maize straw	21
Ragi straw	0.3
Small millet straw	0
Total Cereal Straw	1366
Horse gram straw	0.06
Green gram straw	3.83
Black gram straw	35
Red gram straw	1.8
Bengal gram straw	24
Cow gram straw	0.13
Ground nut straw	64.6
Soyabean straw	0.0058
Total Legume straw	129
SugarCane	231
Palm Press Fiber	6.18

Table.7 Availability of concentrate ingredients (‘000 tonnes) in Nellore districtof Andhra

Concentrate	Tonnes (‘000)
Rice bran	81.69
Wheat bran	0
Pulse Chunnies	1.14
Total Brans & Chunnies	82.83
Sorghum grain	0.24
Bajra grain	0.118
Maize grain	0.82
Ragi grain	0.0074
Millets grain	0
Broken Rice grain	20.42
Wheat grain	0
Total Grains	21.61
Cotton seed cake	0.58
Ground nut cake	19.4
Gingely cake	1.109
Sunflower cake	1.44
Coconut cake	0.435
Soya bean meal	0.0026
Castor cake	0.01066
Miscellaneous oil seed	13
Total Oil Seed Cakes	35.98

Table.8 Contribution of different sources towards total estimated DM availability in Nellore district of Andhra Pradesh

Availability and Requirement	Million tonnes
ACU	670580
Green forages	0.76
Dry forages	6.37
Concentrates	0.48
Total DM availability	7.61
DM Requirement	7.00
Surplus/ Deficit	0.61
% DM Availability	108.75

Table.9 Classification of regions 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

The availability of green forages, dry forages, and concentrates is157.62%, 187.89%, and 18.43% 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).

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