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Research article

Assessment of dry matter availability and fodder deficiency in Andhra Pradesh: a district-wise analysis

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Abstract

This study evaluated the availability of dry matter (DM) for livestock in Andhra Pradesh, a state crucial for livestock production in India. The research covered all 13 districts, utilizing crop production data from 2015-2019 and 20th livestock census data to quantify DM availability from crops and land use classifications. The districts were categorized based on DM availability into surplus, adequate, moderately adequate, and deficient relative to the livestock population. The results indicated that while the state has a satisfactory DM availability of 97.04%, there is significant variation among districts. Five districts are classified as surplus, three as adequate, two as moderately adequate, and three as deficient. Crop residues are the primary source of DM, contributing 69.27% to the total DM availability, followed by greens from gross cropped areas and concentrates. The study highlights that districts with high irrigation facilities and diverse crop patterns tend to have higher DM availability. Mechanized harvesting and burning crop residues are identified as factors reducing fodder availability. At the micro-level, surveys conducted in East Godavari (surplus), Srikakulam (adequate), and YSR Kadapa (deficient) districts revealed that even in surplus and adequate districts, there is a shortage of concentrates due to cost factors and farmer preferences. This research underscores the need for systematic fodder planning strategies tailored to district-specific conditions to ensure sustainable livestock production and livelihood security for small and marginal farmers.

Keywords: Crop residue, Dry matter availability, Fodder planning strategy, Green Fodder, Livestock production

Introduction

In developing countries like India, livestock production has been the backbone of agriculture, a source of employment and food and nutritional security in rural areas. Therefore, India has been home to major draught, milch and dual-purpose breeds of cattle, which are distributed across different states of India. The demand for forages, however, is increasing due to the rearing of high-yielding crossbred animals. Sustenance of livestock corresponds with fodder availability. In today's scenario, systematic planning of fodder and feed resources is required to ensure the survival of not only animals but also the livelihood of the vast majority of small and marginal livestock owners. Quantification of existing feed resources is necessary for the development of efficient feeding strategies and for the judicious utilization of available feed resources. Further, no published literature is available on the availability of district-wise feed resources for livestock in Andhra Pradesh. Andhra Pradesh needs to pursue a systematic fodder planning strategy because it is the country's most flood-affected state in South India. The present paper brings out the availability of fodder as dry matter to the livestock, keeping the district as the smallest unit. Some past efforts were reported by Raju *et al.* (2002), Anandan *et al.* (2003) and Anandan *et al.* (2005), but were based on crop production data of 1996–97, and Biradar and Kumar (2013) accounted for data from 2005-11. The objectives of the present paper are to classify districts of Andhra Pradesh based on DM availability to the livestock and to understand the management of fodder deficiency by the rural households of the state.

Materials and Methods

***Study area and data source*:** The study was conducted in Andhra Pradesh, with its districts as units. Andhra Pradesh had a total of 13 districts during the study

period. The study used both primary and secondary data. Crop production data of 24 crops for four years, 2015-2019, was obtained from the Directorate of Economics and Statistics, GoI (Anonymous, 2020a). The average production of different crops in these four years was calculated to account for any production variation due to climatic variability. Average values so derived were used to calculate dry matter production from different crops. Secondary data on land use classifications of each district of Andhra Pradesh was collected from the Directorate of Economics and Statistics, GoI (Anonymous, 2020a). Besides, secondary data on livestock numbers as per the 20th livestock census were collected from the Department of Animal Husbandry and Dairying, GoI (Anonymous, 2020b). Using this data, livestock numbers were converted into Adult Cattle Units as recommended by Ramachandra *et al.* (2007; Table 1).

Primary data was collected from three districts of Andhra Pradesh, each belonging to a different DM availability category. These districts were East Godavari from surplus, Srikakulam from adequate and YSR Kadapa from deficient DM categories. From each district, one block and two villages were selected randomly. From each village, 20 livestock farmers belonging to different landholdings were randomly selected for data collection. So primary data was collected from 3 districts, 3 blocks, 6 villages and 120 livestock farmers. Data on livestock holdings, fodder availability and utilization were collected through personal interview techniques using standardized interview schedules to depict the fodder scenario at the micro-level.

Computing availability of dry matter: Crop production data was converted into quantity of straws/stovers (crop residue), grains, husk and bran by using harvest indices and extraction rates as suggested by Anandan and Sampath (2012) with slight modification where instead of uniform harvest indices for all pulses (1.7) specific harvest indices for tur (1.8), gram (1.2) and soybean (1.2) were used (Biradar and Kumar, 2013). Using harvest indices, dry matter for each crop was obtained. For instance, for every 100 tonnes of wheat grain produced, it is converted into100 tonnes of wheat straw (100 multiplied by the harvest index of 1.0), 2 tonnes of wheat grains available for feeding (100 multiplied by the extraction rate of 0.02) and 8 tonnes of wheat bran (100 multiplied by 0.08). The dry matter content for all-crop residues, grains, cakes, and bran/husk was considered as 90%, except for sugarcane tops. For sugar cane tops, 25% dry matter was considered, as it is high in moisture. Dry matter available from all the crops was added and expressed in Million Metric Tonnes (MMT).

Green fodder yields for seven land use types mentioned under land use classifications-gross cropped area, forest area, permanent pastures, cultivable wasteland, current fallows, other fallows and area under miscellaneous tree crops were computed by following the procedure suggested by Ramachandra *et al.* (2007). It is assumed that the average dry matter content of green fodder obtained from all land use classifications is 25%. So, total dry matter availability from crops and land use classifications was worked out using the following formula-

$$DM\ availability\ (MMT) = DMc + DMluc$$

Where in DMc = Dry matter from crops; DMluc = Dry matter from land use classification

Computing requirement of dry matter: Dry matter requirements of ruminants (cattle, buffalo, sheep and goats) are calculated based on a standard adult cattle unit (ACU) of 350 kg body weight, utilizing the conversion factors for livestock species and age class (Ramachandra *et al.* 2007). It is assumed that the dry matter requirement of an Adult Cattle Unit is 2% of body weight (350 kg), which comes to 7kg dry matter/day/ACU, which is equivalent to 2.555 tons/year/ACU. Using this, the total dry matter requirement (DMr) of livestock for each district of Andhra Pradesh was arrived at.

$$DMr\ (t/y) = TotalACUX2.555$$

Where in DMr = Total dry matter requirement (tons/year); Percentage DM availability was worked out to understand to what extent thestate/district had excess/deficit DM using the following formula.

$$\text{Percent DM availability} = \frac{DM\ available}{DM\ required} X100$$

Categorization of districts: The difference between dry matter availability and requirement was calculated and converted into percentages for each district. Based on percent dry matter availability, districts were classified into four groups as surplus (> 100%), adequate (80–100% DM availability), moderately adequate (60–79% DM availability) and deficient (40–59% DM availability) districts.

Table 1. Conversion factors for adult cattle unit (ACU)

Sl. No.	Species	Age	Conversion factor
1	Buffalos	>2.5 years	1.14
		1.0–2.5 years	0.50
		<1.0 years	0.17
2	Cattles (cow + bullocks)	>2.5 years	1.00
		1.0–2.5 years	0.34
		<1.0 years	0.11
3	Sheep/goat	1.0 years	0.10
		<1.0 years	0.03

Contribution of different sources to DM availability: Sources of dry matter are crop residues (Crop production data), greens (land use classification data) and concentrates (crop production data). Crop production data for concentrate estimation was used as cereals, pulses and oilseeds from base material to prepare concentrates. These sources were further divided as sub-sources viz. coarse straw, fine straw, leguminous straw, sugarcane tops for crop residues; gross cropped area, fallows, forests, pastures, and others for greens and grains, brans and chuni, oil cakes for concentrates. The percentage contribution of each source and sub-source towards total dry matter availability was arrived at to understand which source is contributing the highest to the total dry matter.

Results And Discussion

Classification of districts in Andhra Pradesh based on extent of estimated DM availability to the livestock: In Andhra Pradesh, out of the 13 districts, 5 districts (38.46%) belonged to the surplus (>100%) DM available category (Table 2). Three districts (23.08%) belonged to adequate (80–100%), 2 districts (15.38%) belonged to moderately adequate (60–79%) and 3 districts (23.08%) belonged to deficient (40-59%) DM available categories. The mean DM availability for the state was 99.90 ± 47.77%, indicating a very negligible DM deficiency in the state.

The mean dry matter (DM) availability in Andhra Pradesh was 99.90 ± 47.77%. Though the state as a whole depicts a very satisfactory scenario, the distribution of districts indicates variations (Reddy *et al.* 2018). While 5 districts belonged to the surplus category, 3 districts belonged to the deficient category. This variation could be attributed to the availability of irrigation, crops cultivated and livestock density prevailing in the state.

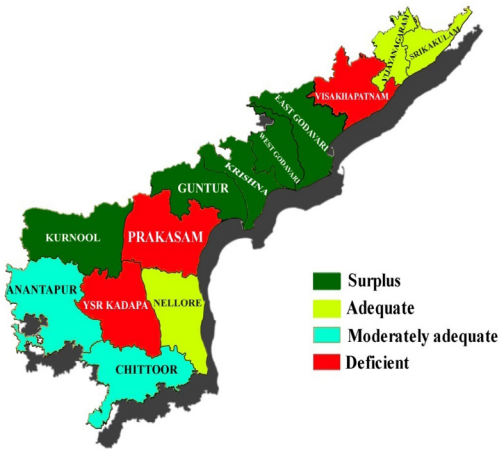

Fig 1. Spatial distribution of districts of Andhra Pradesh based on estimated dry matter availability

Table 2. Classification of districts as per estimated DM availability

Categories	Criteria (% DM availability)	No of districts	Percentage of districts
Surplus	>100	5	38.46
Adequate	80–100	3	23.08
Moderately adequate	60–79	2	15.38
Deficient	40–59%	3	23.08
Total		13	100
State mean (%)	99.90		
State SD (%)	47.77		

District-wise fodder status in Andhra Pradesh: Results pertaining to district-wise DM availability were recorded (Table 3; Fig 1). West Godavari (219.21%), Krishna (145.57%), East Godavari (143.78%), Kurnool (112.28%), and Guntur (106.17%) districts belonged to the surplus DM available category and the mean percentage of DM availability for this category was (145.41%). The highest DM available district in the state was West Godavari. Vizayanagaram (99.41%), Nellore (91.80%), and Srikakulam (85.37%) districts belonged to the adequate DM available category. The mean percentage of DM availability for this category was 92.20%. Chittoor (72.56%) and Anantapur (60.59%) districts belonged to the moderately adequate category. The mean percentage of DM availability for this category was 66.58%. Vishakapatnam (56.85%), Prakasam (56.29%) and Kadapa (48.76%) districts belonged to the deficient category, with the category mean of only 53.97 % DM availability. Overall, Andhra Pradesh state belonged to the adequate category with total dry matter availability of 97.04%. West Godavari (119.22%), Krishna (45.57%), and East Godavari (43.79%) have surplus DM. The main reason was the large area under paddy crops. In some of these districts, paddy is cultivated in all three seasons.

Kurnool (12.28%) and Guntur (6.18%) show marginal surplus DM availability due to prevailing crop diversity in these two districts (Reddy *et al.* 2018). Three districts, Vijayanagaram (99.41%), Nellore (91.82%) and Srikakulam (85.37%), belonged to adequate DM availability. Though paddy is cultivated in all these districts, but only for one season. In the remaining seasons, pulse crops like green gram and black gram are cultivated, which yield less quantity of crop residue. Chittoor and Anantapur districts are associated with the moderately adequate DM available category. Chittoor has the highest livestock population in the state. So, the livestock density is higher in this district. Anantapur district, though it belongs to a scarce rainfall zone, has some parts of the district that receive assured rainfall. So, paddy is cultivated in one season and groundnut is cultivated in the rabi season. So, moderate adequacy of DM was the possibility here. Three deficient districts are Vishakapatnam,

Table 3. District wise fodder status in Andhra Pradesh

District	Dry matter (MMT)			Percentage		Status
	Available	Required	Difference	Availability	Difference	
West Godavari	3.79	1.73	2.06	219.21	119.22	Surplus
Krishna	2.31	1.59	0.72	145.57	45.57	Surplus
East Godavari	2.93	2.04	0.89	143.78	43.79	Surplus
Kurnool	2.32	2.07	0.25	112.28	12.28	Surplus
Guntur	2.22	2.09	0.13	106.17	6.18	Surplus
Mean percentage availability of surplus districts			145.41			
Vizayanagaram	1.28	1.29	-0.01	99.41	-0.59	Adequate
Nellore	1.80	1.96	-0.16	91.80	-8.19	Adequate
Srikakulam	1.11	1.30	-0.19	85.37	-14.62	Adequate
Mean percentage availability of adequate districts			92.20			
Chittoor	1.67	2.30	-0.63	72.56	-27.44	Moderately adequate
Anantapur	1.61	2.65	-1.05	60.59	-39.41	Moderately adequate
Mean percentage availability of moderately adequate districts			66.58			
Vishakapatnam	1.15	2.02	-0.87	56.85	-43.14	Deficient
Prakasam	1.35	2.39	-1.05	56.29	-43.71	Deficient
Kadapa	0.81	1.66	-0.85	48.76	-51.24	Deficient
Mean percentage availability of deficient districts			53.97			
Total	24.35	25.09	0.74	97.04	-2.96	Adequate

MMT: Million metric tons

Prakasham, and Kadapa. Among the three, two districts are drought-prone, leading to multiple crop failures. The fodder scarcity during drought years increased the vulnerability of pastoralism in the Banni grasslands. The cost of livestock rearing increased during drought years because of the purchase of fodder resources and a general reduction in milk production. They purchased fodder and concentrate feed from the market for their livestock, especially for milking buffaloes and cows, to supplement with natural grazing (Manjunatha *et al.,* 2025). Most of the areas in these two districts are diverted for the cultivation of fruit crops such as orange, mango, and ber (Anonymous, 2008). This might be the reason for low DM availability.

Percentage contribution of different sources to total DM availability: Crop residues comprise straws and stovers obtained after harvesting the crops. Crop residues are the major feed resource for feeding livestock across all districts. The contribution of crop residue to the total dry matter availability in the state was 64.73% (Table 4). Its contribution was highest (73.17%) in adequate districts and lowest in moderately adequate districts (45.80%). Chittoor and Anantapur districts have high leguminous straw availability primarily due to their large-scale cultivation of groundnut, a key legume crop grown extensively in these semiarid regions. Groundnut straw is a major component of the crop residue used as animal feed in these areas, which is particularly significant because these districts rely heavily on crop residues for livestock, especially the dry and scarce rainfall zones of Andhra Pradesh. The contribution of greens to the total dry matter is mainly from gross cropped area. Nearly 4% of cultivable area is estimated to be under fodder crops. This area is contributing nearly 41.17% to the total dry matter availability in deficit districts. This is followed by 33.26% in moderately adequate districts, 18.74% in adequate districts, and 16.23% in surplus districts. The contribution of total greens from all sources is more in deficit districts than surplus districts. Its contribution to the state DM is 22.19%. Among the concentrates, oilcakes contribute more in all the categories. Its oil cakes contribute more in moderately adequate districts (19.81%) and lowest in deficit districts (4.07%) for the state concentrates (13.07%; Reddy *et al.,* 2018).

***Contribution of different DM sources across districts of Andhra Pradesh*:** Contribution of various sources to the total dry matter availability was plotted in a graph (Fig 2). The trend indicated that, as the contribution of crop residues decreased across the districts, the contribution of greens increased. Apart from the production shortage of dry fodder, another reason that reduces the fodder availability to livestock is the burning of crop residues.

Table 4. Percentage contribution of different sources towards the total estimated DM availability in different categories of districts of Andhra Pradesh

Source	Percentage dry matter Availability				
	Surplus > 100% DM availability	Adequate > 80% DM availability	Moderately adequate 60-79% DM availability	Deficient DM availability 40-59%	State
Crop residue					
Coarse straw	18.55	18.05	7.10	7.52	15.50
Fine straw	37.22	43.04	11.56	17.02	32.21
Leguminous straw	7.80	4.12	14.43	12.80	8.68
Sugarcane tops	5.70	7.96	12.71	15.70	8.33
Total crop residues	69.27	73.17	45.80	53.03	64.73
Greens					
Gross cropped area	10.95	10.92	16.50	15.17	12.23
Fallows	1.11	1.85	6.34	5.42	2.49
Forests	3.30	4.12	7.79	16.68	5.80
Pasture	0.55	1.19	1.58	2.66	1.08
Others*	0.32	0.65	1.04	1.23	0.59
Total greens	16.23	18.74	33.26	41.17	22.19
Concentrates					
Grains	1.21	1.26	0.42	0.53	1.03
Brans and chuni	2.40	2.69	0.72	1.20	2.07
Oil cakes	10.89	4.14	19.81	4.07	9.97
Total concentrate	14.50	8.09	20.95	5.80	13.07

*Others: Miscellaneous tree crop

Apart from the production shortage of dry fodder, the other reason that reduces the fodder availability to livestock is the mechanized harvesting with combine harvesters (Gupta *et al.*, 2003). So livestock farmers depend more on greens when crop residue availability is reduced. This means farmers are allotted land for the cultivation of fodder crops, which may be annual or perennial. Because a major chunk of green comes from gross cropped area (Reddy *et al.*, 2018). However, there is not much variation observed in terms of concentrate utilization by different districts. Crop residue explained 97% variation in greens and explains 98% variation on dry matter availability across the districts. Concentrates did not express much variation among the districts.

Contribution of different sources to total crop residues: Contribution of different sources to total crop residues was recorded (Fig 3). The graph clearly indicates that as the contribution of coarse straw (sorghum, bajra, and maize) decreases, the contribution of fine straw (rice, wheat, ragi and small millets) increases in some of the districts. However, the proportion of increase is not

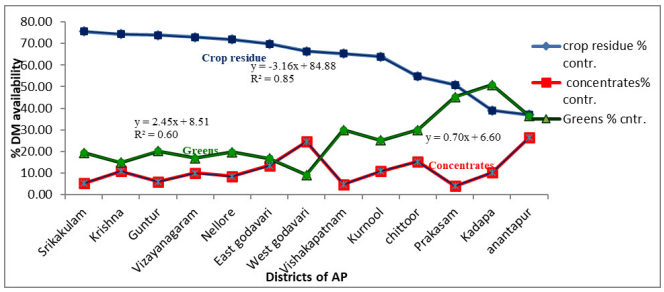

Fig 2. Trend showing the contribution of different DM sources across the districts of Andhra Pradesh

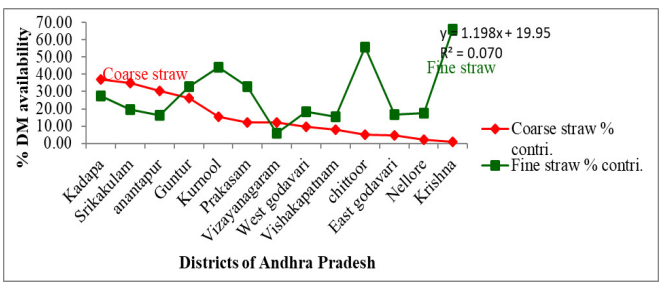

Fig 3. Graph showing the contribution of different crop residues across the districts of Andhra Pradesh

Table 5. Annual feed and fodder availability and requirement for livestock in respondents' households (n = 120)

Type	Districts	Average herd sizehousehold (ACU*)	Average fodder/ACU		Difference (tons)	Status
			Requirement (tons)	Availability (tons)		
Green fodder	East Godavari (Surplus)	4	2.83	8.50	5.67	Surplus
	Srikakulam (Adequate)	3	2.49	3.09	0.60	Surplus
	YSR Kadapa (Deficient)	4	2.63	2.08	-0.56	Deficient
Dry fodder	East Godavari (Surplus)	4	2.02	6.25	4.43	Surplus
	Srikakulam (Adequate)	3	1.78	2.08	0.30	Surplus
	YSR Kadapa (Deficient)	4	1.88	1.39	-0.50	Deficient
Concentrates	East Godavari (Surplus)	4	1.21	0.09	-1.12	Deficient
	Srikakulam (Adequate)	3	1.07	0.11	-0.96	Deficient
	YSR Kadapa (Deficient)	4	1.13	0.08	-1.05	Deficient

in correspondence with the decrease between coarse and fine straw (Yadav *et al.*, 2017 and Reddy *et al*., 2018). In coastal districts like West Godavari, East Godavari and Nellore, the contribution of coarse straw is almost negligible. This is due to the cropping pattern followed in these districts.

Contribution of legume straw to total crop residue: This was felt to be important as legumes enrich the quality of crop residues used for feeding to the livestock. The extent of availability of legume straw across the districts was also recorded (Fig 4). Vijayanagaram gets more leguminous straw (22.19%). In this district, pulse crops are cultivated widely. Even the neighboring districts of Vijayanagaram and Srikakulam cultivated more pulse crops like green gram and black gram in the rabi season. The contribution of leguminous straw is almost negligible in the districts like YSR Kadapa (2.98%), Chittor (1.55%), Prakasam (1.12%), and Vishakapatnam (0.91%). This protein-rich straw contributes 8.68% to the total dry matter availability of the state.

Annual feed and fodder availability and requirement for livestock in respondents' households: The mean herd size in East Godavari (surplus) and YSR Kadapa (deficient) districts was 4 adult cattle units (ACU) each, while it was 3 ACU in Srikakulam (adequate) district.

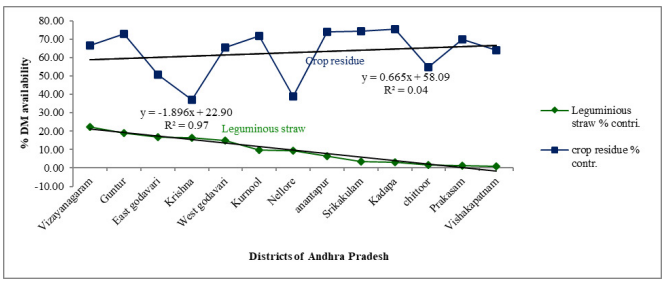

Fig 4. Percentage DM availability from legume straw to the total crop residue in all districts of Andhra Pradesh

In East Godavari district, green fodder is available in surplus, almost 5.67 tons more than the requirement per ACU/year. In Srikakulam (adequate), the average excess green fodder available was only 0.60 tons/ ACU/ year. Respondents of the Kadapa (deficient) district experienced an average green fodder shortage of 0.56 tons/ACU/year (Table 5). East Godavari (surplus) and Srikakulam (adequate), which have had surplus dry fodder of 4.43 and 0.30 tons/ACU/year, respectively, only the Kadapa (deficient) district showed a deficiency of 0.50 tons/ACU. However, in the case of concentrates, respondents of all three districts mentioned that they experienced a shortage of concentrates, which was 1.12 tons/ACU in East Godavari (surplus), 0.96 tons/ACU/ year in Srikakulam (adequate) and 1.05 tons/ACU/year in YSR Kadapa (deficient) districts. The mean herd size was four ACU/ household in East Godavari (surplus) and YSR Kadapa (deficient) districts. But in YSR Kadapa, the deficient district's availability of green fodder is deficient by 0.56 tons, dry fodder is deficient by 0.50 tons, and concentrates are deficient by 1.05 tons/ACU/ year. This particular district belonged to a drought-prone area facing severe fodder scarcity. East Godavari and Srikakulam, though, belonged to surplus and adequate DM categories, respectively. Still, both have irrigation facilities with high water tables, so paddy is cultivated in 2-3 seasons, leading to good production of paddy straw. However, all three districts experienced a deficiency in concentrate, possibly because of households' unwillingness to purchase concentrates, and also the cost factor discourages farmers from purchasing concentrated feeds (Raju *et al.*, 2017).

Conclusion

The present study provides a district-wise assessment of dry matter (DM) availability for livestock in Andhra Pradesh by integrating secondary data on crop production, land use and livestock population with micro-level household information from three contrasting districts.

The analysis shows that, although the state as a whole appears nearly self-sufficient in DM on an annual average basis, there are sharp inter-district disparities, with some districts falling in surplus and adequate categories while others remain moderately adequate or deficient. Crop residues emerged as the major source of DM, but their contribution is strongly influenced by irrigation, cropping patterns, mechanized harvesting and residue management practices such as burning. Greens from gross cropped area and common lands, and concentrates from grains, brans and oil-cakes, supplement DM availability but are inadequate to compensate for deficits in several districts. Primary data further revealed that even in surplus and adequate districts, households experience shortage of concentrates due to high cost and low willingness to purchase, while deficient districts face simultaneous scarcity of green, dry fodder and concentrates. These findings underline the need for district-specific fodder planning that explicitly accounts for practical constraints, residue losses and climatic variability, and promotes fodder crop intensification, improved residue utilization, and better access to concentrates to support sustainable livestock production and resilient livelihoods.

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