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Estimation of demand and supply of livestock feed and fodder in Rajasthan: a disaggregated analysis

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ABSTRACT

The paper estimates the district level availability and requirement of livestock feed and fodder in Rajasthan using secondary data of triennium ending 2008–09. Availability of dry fodder and concentrates were estimated using appropriate conversion ratios to different field crop production, while green fodder was estimated by applying per hectare yield to different fodder sources. The requirement was worked out by converting livestock into adult cattle units and multiplying by per unit consumption capacity. The annual availability of feed and fodder in the state was estimated at 51.54 million tonne is against the requirement of 68.61 million tonne and thereby deficit of around 25% per annum. The feed deficiency was estimated almost in all the districts except in the districts of Hanumangarh, Bikaner, Jaisalmer, Churu and Ganganagar. The eastern and south eastern districts were deficit in green fodder whereas western and southern hill districts were deficit in dry fodder. Other critical dimensions were low roughage: concentration ration (1:0.06) and high population pressure on pasture and grazing lands. The policies to develop silvi-pastoral model, creation of fodder banks/ storage facilities, strengthening extension system, developing drought resistant and high yielding variety, crop varieties with emphasis on fodder component needs priority attention.

Key words: Common property resources, Carrying capacity, Feed gap, Fodder demand, Fodder supply

Livestock production is an integral part of the farming system in the rainfed areas, especially in the ecologically fragile semi-arid areas. The contribution of livestock sector is much higher in Rajasthan as compared to other parts of country. The contribution of livestock in value of output from agriculture at current prices in the state during 2008–09 was 36.84% while the corresponding figure at all India level was 26.87% (CSO 2011). However, there are numbers of supply side constraints in livestock production in the country. Availability of feed in quantity as well as quality is one of the most limiting factors to improve the livestock productivity (Birthal and Jha 2005). The supply of feeds has always remained short of normative requirement (Jain *et al.* 1996, Singh *et al.* 1997, Ramachandra *et al*. 2007, Dikshit and Birthal 2010, Thirunavukkarasu *et al.* 2011, GoI 2012). The situation is further aggravated in Rajasthan where considerable area falls in arid and semi-arid zones.

To compensate for the low productivity of livestock, farmers maintain a large herd of animals, which triggers a vicious circle of continuous livestock increase. This causes sharp acceleration of environmental degradation consequent to surpassing carrying capacity and sustainability of natural environment.

Up-to-date information on feed and fodder requirement for livestock is essentially required for livestock development planning not only for short-term and long-term planning but also to develop a feed security system in the state. Although several attempts have been made to estimate the livestock feed and fodder availability in the country, very few and up-to-date comprehensive studies are available on estimation of availability and requirement of feed at disaggregated level, particularly in arid and semi-arid region of country where livestock plays an important role. The present study develops a more realistic methodology and estimates feed availability and requirement in Rajasthan at district level.

MATERIALS AND METHODS

Data source: The study is entirely based on secondary data. District level data regarding land use, area and production under different crops, livestock population for triennium ending 2008–09 were collected from various published and unpublished sources.

Estimation of availability of livestock feed: Livestock

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feed availability was estimated on dry matter (DM) basis from (i) roughages which includes straw and stalk, fodder (green and dry), grass, etc., and (ii) concentrates which are made up of oilcakes, crushed pulses, grains, wheat and rice bran, husk, etc. The percentage of dry matter in different kind of feed and fodder was used as suggested by Ranjhan *et al.* (1999).

Roughages: Dry fodder from crop-residues of various utilizable cereals, pulses and oilseed crops was estimated based on the grain-to-straw ratio taken in earlier studies (Jain *et al.* 1996, Ramachandra *et al.* 2007) as well as based on information taken from subject matter specialist in the study area. Further, it was assumed that 95% of crop-residues are consumed by livestock (CSO 2012).

Estimation of green fodder was made from the resources like forage crops, grasses from forest, pastures and grazing lands, cultivable wasteland, etc. The data on area under fodder crops, both irrigated as well as unirrigated, forest, pasture and grazing lands and cultivable wasteland were collected from Land Utilization Statistics published by the Directorate of Economics and Statistics, Government of India. The average yield of cultivated green fodder was taken as 50 and 25 tonnes/ha under irrigated and unirrigated conditions, respectively (CSO 2012), from forest land 1.5 tonnes/ha and 1 tonne from fallow lands, cultural wastelands and miscellaneous tree crops (Ramachandra *et al.* 2007 and DAHD Undated), and 0.3 DM tonne from permanent pasture and grazing lands, an average biomass yield on dry matter basis suggested by CSWRI (Undated).

Concentrates: The concentrates are made up of oilcakes, crushed pulses, grains, rice polish and wheat bran. It was assumed that 2% of wheat, 10% of maize, 1% of rice, 5% of barley, sorghum, pearl millet and finger millet are fed to the animals (Jain *et al.* 1996). In addition to the grains, wheat bran and rice polish were estimated to be 6% of wheat production and that of rice polish to be 3% of rice production, respectively (Jain *et al.* 1996). To estimate the production of oilseed cakes, the ratio of meal to seed was used as 55.7% of rapeseed and mustard, 31.7% of sunflower, 29.5% of soybean, 44.9% of groundnut, 67% of linseed, 39.4% of sesamum and nigerseed, and 10.4% of cottonseed (per bale) (Ranjhan *et al.* 1999) and it was assumed that 85% of oilcake production is assumed to be available for livestock population.

Estimation of livestock feed requirement and gap: The requirement of animal feed on dry matter basis was estimated based on Livestock Population Census (2007). The district wise livestock population of the state was converted into adult cattle units (ACUs) as per Bhati (1981) and Kumbhare *at al*. (1983). The capacity of consumption for the appetite of the animal is measured by the amount of dry matter in the ration, which an animal can consume. The dry matter consumption was used @ 7 kg/ACU/day (i.e. 2% of the body weight of 350 kg) which is in accordance with GoI (2002) and Ramachandra *et al.* (2007). Based on the field survey of irrigated region of Rajasthan, Chand and Sirohi (2012) reported average DMI as 10 kg/animal for buffaloes and crossbred cows that is approximately equivalent to 7.5 kg/ACU. Similarly, Dikshit and Birthal (2010) also found all-India average feed consumption rate to be about 7.4–8.8 kg DM for adult female buffaloes (ACU=1.3). The district wise feed demand was estimated by multiplying the annual feed consumption per ACU with total number of ACUs in the respective district. The feed balance was then computed as% gap between the demand and production.

RESULTS AND DISCUSSION

Estimation of dry fodder availability: The availability of dry fodders on dry matter basis was estimated from cereals, pulses and other sources like oilseeds, guar seed, etc., (Table 1). The total dry fodder in the state was estimated 23.94 million tonnes accounting nearly 6% of the dry fodder production from all-India level (GoI 2012). More than 90% of dry fodder was contributed by straws, stalks and stovers of cereals. Pulses formed nearly 3% while about 7% was coming from other sources include oilseed, guar seed, etc. Among different districts, Alwar contributed highest

Table 1. District level availability of dry fodder from different sources in Rajasthan

(DM in '000 tonnes)

District	Cereals	Pulses	Others	Total
Ajmer	366.50	12.29	5.85	384.64
Alwar	1752.81	8.25	91.50	1852.57
Banswara	707.01	12.64	5.25	724.90
Baran	454.96	3.41	89.93	548.30
Barmer	282.52	13.07	19.73	315.32
Bharatpur	1106.25	4.48	66.57	1177.31
Bhilwara	826.75	13.17	18.43	858.35
Bikaner	335.59	67.23	183.22	586.04
Bundi	649.53	12.58	34.76	696.88
Chittorgarh	1340.37	7.14	59.66	1407.17
Churu	537.03	80.94	54.18	672.15
Dausa	805.94	2.48	41.71	850.13
Dholpur	549.74	2.16	18.37	570.26
Dungarpur	295.97	10.45	1.02	307.45
Ganganagar	869.09	52.10	118.47	1039.66
Hanumangarh	1092.28	53.74	138.91	1284.93
Jaipur	1529.12	30.53	97.78	1657.43
Jaisalmer	40.54	14.52	19.69	74.75
Jalore	385.54	15.76	29.15	430.45
Jhalawar	420.64	19.01	80.40	520.05
Jhunjhunu	841.27	37.75	25.83	904.85
Jodhpur	670.90	28.37	68.07	767.34
Karauli	804.55	6.81	27.88	839.24
Kota	442.37	4.95	67.38	514.69
Nagaur	1158.41	91.79	63.30	1313.50
Pali	284.25	14.09	22.81	321.15
Rajsamand	281.86	0.40	4.75	287.02
Sawaimadhopur	455.99	8.81	41.42	506.22
Sikar	1018.64	29.08	55.52	1103.24
Sirohi	171.72	2.47	10.66	184.84
Tonk	386.14	13.62	45.29	445.05
Udaipur	778.39	7.68	10.84	796.92
Rajasthan	21642.68	681.79	1618.34	23942.81

followed by Jaipur, Chittorgarh, Nagaur and Hanumangarh. These 5 districts contributed nearly 1/3rd of the total dry fodder production from the state. Around 34% of *bajra*, 35% of rice and 45% of barley of the state is being produced by these districts.

Estimation of green fodder availability: The green fodder production available from forage crops, pasture and grazing lands, forest, cultivable waste lands, tops of sugarcane, potato and sweet potato (Table 2). The total green fodder in the state on dry matter basis was estimated 24.87 million tonnes. Interestingly, around 46% of total green fodder of state was contributed only by 5 arid western districts namely Bikaner, Jaisalmer Barmer, Churu and Jodhpur. Despite less irrigation facilities and low rainfall, the green fodder production in these districts is high because of higher area under unirrigated fodder crops, pastures and grazing land, and cultivable waste lands. Similarly, canal irrigated districts namely Hanumangarh and Ganganagar each contributed around more than 5% of total green fodder production in the state. Southern and eastern flood prone districts namely Dholpur, Banswara, Swaimadhopur, Bharatpur and Dungarpar that had higher dry fodder availability were worse-off in terms of green fodder production.

On an average 61% of total green fodders are accounted by cultivated forage crops. There was wide inter-district

Table 2. District-wise availability of green fodder from different sources in Rajasthan

(DM in '000 tonnes)

Districts	Fodder from forage crops			Grasses	Tops	Total green fodder
	Irrigated	Un-irrigated	Total			
Ajmer	31.98	55.79	87.76	362.21	0.09	450.06
Alwar	53.45	156.55	210.01	140.64	0.28	350.93
Banswara	5.16	4.83	9.99	112.21	0.57	122.77
Baran	3.09	9.04	12.13	260.84	0.13	273.1
Barmer	22.74	1513.04	1535.78	878.96	0.00	2414.74
Bharatpur	16.13	117.11	133.24	50.06	3.23	186.53
Bhilwara	49.98	177.58	227.56	556.91	0.59	785.06
Bikaner	619.32	2386.43	3005.75	455.54	0.01	3461.3
Bundi	17.56	55.15	72.71	180.18	5.95	258.84
Chittorgarh	52.73	61.07	113.81	462.77	2.37	578.95
Churu	4.22	1444.59	1448.81	157.21	0.00	1606.02
Dausa	12.41	65.20	77.61	119.24	0.01	196.86
Dholpur	6.43	9.69	16.11	88.20	3.60	107.91
Dungarpur	4.70	12.87	17.57	176.64	0.40	194.61
Ganganagar	1159.62	283.37	1442.99	41.17	8.28	1492.44
Hanumangarh	904.64	921.91	1826.55	25.91	0.21	1852.67
Jaipur	140.52	207.89	348.41	360.91	0.10	709.42
Jaisalmer	138.81	1324.09	1462.90	1080.26	0.00	2543.16
Jalore	47.92	241.25	289.17	209.84	0.08	499.09
Jhalawar	12.65	7.89	20.54	271.89	0.16	292.59
Jhunjhunu	88.43	249.57	338.01	180.72	0.00	518.73
Jodhpur	108.37	699.74	808.11	502.68	0.00	1310.79
Karauli	2.83	17.93	20.77	217.61	0.31	238.69
Kota	8.35	16.05	24.40	325.71	0.25	350.36
Nagaur	56.24	553.59	609.83	302.70	0.14	912.67
Pali	38.21	278.77	316.98	419.44	0.00	736.42
Rajsamand	28.49	38.90	67.39	274.20	1.41	343
Sawaimadhopur	4.49	25.58	30.07	143.58	0.13	173.78
Sikar	86.98	304.81	391.79	196.99	0.18	588.96
Sirohi	45.65	82.23	127.88	217.70	0.04	345.62
Tonk	18.57	55.30	73.87	195.05	0.13	269.05
Udaipur	19.31	88.13	107.44	598.12	1.98	707.54
Rajasthan	3809.98	11465.95	15275.93	9566.08	30.65	24872.66

variability in green fodder availability from forage crops. In north western districts namely Hanumangarh and Ganganagar, more than 95% of green fodder came from forage crops while in south districts namely Kota, Baran, Jhalawar and Banswara, the major green fodder source was grasses and trees from forest areas. Tops of sugarcane, potato and sweet potato accounted negligible to green fodders production in the state (Table 2). Further, it is interesting to note that 3rd/4th of green fodder from forage crops was contributed by rainfed area and availability of which varies year to year as it gets affected by monsoon. Common Property Resources (CPRs) are important nutritional source for small holders and small ruminant farmers. In Rajasthan, CPRs constitute major source of green fodder for 85–99% of the farmers during all the seasons (Suresh *et al.* 2007), although in terms of production only 38% of green fodder was contributed by CPRs.

Table 3. District-wise and source-wise availability of concentrates in Rajasthan

(DM in '000 tonnes)

District	Grains, wheat bran and rice police	Oilseed cakes	Total concentrates
Ajmer	10.53	6.14	16.67
Alwar	74.84	179.11	253.95
Banswara	32.46	5.05	37.51
Baran	30.66	132.78	163.44
Barmer	6.42	6.89	13.31
Bharatpur	53.78	150.93	204.71
Bhilwara	36.52	18.74	55.26
Bikaner	12.43	48.85	61.28
Bundi	39.90	54.66	94.56
Chittorgarh	61.48	70.13	131.61
Churu	12.23	21.18	33.41
Dausa	30.42	58.12	88.54
Dholpur	21.15	41.94	63.09
Dungarpur	13.14	0.52	13.66
Ganganagar	58.86	134.39	193.25
Hanumangarh	61.49	60.45	121.94
Jaipur	54.91	82.76	137.67
Jaisalmer	1.34	18.10	19.44
Jalore	10.27	40.87	51.14
Jhalawar	22.64	93.15	115.79
Jhunjhunu	30.63	44.53	75.16
Jodhpur	18.50	67.11	85.61
Karauli	28.79	56.56	85.35
Kota	29.34	105.14	134.48
Nagaur	32.84	49.11	81.95
Pali	10.63	22.98	33.61
Rajsamand	12.28	2.13	14.41
Sawaimadhopur	18.20	84.32	102.52
Sikar	35.06	46.43	81.49
Sirohi	8.53	11.39	19.92
Tonk	15.48	84.68	100.16
Udaipur	33.86	8.14	42.00
Rajasthan	919.61	1807.27	2726.88

Estimation of concentrates availability: The availability of concentrates in the state was estimated to the tune of 2.73 million tonnes (Table 3). The highest concentrates were estimated in the eastern districts namely Alwar and Bharatpur where dry fodder production was higher as availability of concentrations and dry fodder are liked with food crop production. While comparing with the earlier estimates (Jain *et al.* 1996), it appears that the availability of concentrates in the state is almost stagnant as the case of all-India estimates (Sampat *et al.* 2005).

Livestock feed and fodder supply-demand balance sheet: The annual demand for livestock feed and fodder on the basis of adult cattle units and per unit intake capacity was estimated to be 68.61 million tonnes on dry matter basis (Table 4) which comes around 1/10th of all-India feed and fodder demand estimated by Dikshit and Birthal (2010). There was a wide inter-district variability in the feed demand due to variability in the livestock population as well as its composition. The highest demand exists in Jaipur followed by Udaipur, Barmer, Alwar and Jodhpur as these districts have higher population of dairy animals.

The percentage gap between the feed demand and supply was estimated to the tune of 24.88% in the state (Table 4). The State Animal Husbandry Department of Rajasthan also estimated the feed deficit at around 27% in the state (GoR 2007). In case of drought and western arid districts, the shortage become more acute and goes up to 2/3rd of the demand (Singh 2011, Narain and Kar 2005). The shortfall was not uniform across the districts. It was highest in Dungarpur district (69.59%) followed by Ajmer (62.72%) Banswara (60.44%), Udaipur (59.32%) and Rajsamand (55.56%). In general, the deficits were higher in southern districts. The livestock feed exceeded the demand in 5 western and north western districts,viz. Hanumangarh, Bikaner, Jaisalmer, Churu and Ganganagar. It was because of well irrigated facility availability in the districts of Hanumangarh and Ganganagar, while in remaining western districts it was because of low livestock density. The regional variations were also observed in southern state of Karnataka (Raju *et al.* 2002, Anandan *et al.* 2003) and Himachal Pradesh (Dev *et al.* 2006).

Livestock population pressure of common property resources: The livestock population pressure on feed and fodder resources, viz. permanent pasture and grazing lands, and net area sown was worked out in terms of area available per ACU and presented in Table 4. The overall pressure on livestock feed resources (both grazing lands and net area sown) in the state as a whole was worked out to be 1.43 ACU/ha. For pasture and grazing lands, it was estimated at 15.84 ACU/ha, which is very high as compared to the carrying capacity of CPRs in the semi-arid (Shankar and Gupta 1992) and in arid regions (0.2– 0.5 adult cattle unit; Raheja 1966). It is also very high in comparison to the Himachal Pradesh where the average grazing pressure was

Table 4. Supply, demand and gap of livestock feed and fodder demand across districts of Rajasthan

Districts	Feed and fodder demand		Feed and fodder supply (DM)	Gap (%)	Livestock population pressure		
	ACU (No.)	Feed demand (million tonne)			Grazing lands (ACU/ha)	Net Area sown (ACU/ha)	Grazing lands and NSA (ACU/ha)
Ajmer	891.38	2.28	0.85	–62.72	11.37	2.12	1.79
Alwar	1244.95	3.18	2.46	–22.64	51.42	2.48	2.36
Banswara	879.68	2.25	0.89	–60.44	71.46	3.75	3.57
Baran	542.91	1.39	0.98	–29.50	15.18	1.62	1.47
Barmer	1419.39	3.63	2.74	–24.52	7.01	0.85	0.76
Bharatpur	625.58	1.60	1.57	–1.88	77.81	1.59	1.55
Bhilwara	967.87	2.47	1.70	–31.17	8.03	2.39	1.84
Bikaner	1018.75	2.60	4.11	58.08	19.77	0.76	0.73
Bundi	571.79	1.46	1.05	–28.08	23.39	2.24	2.04
Chittorgarh	1203.05	3.07	2.12	–30.94	14.14	2.67	2.24
Churu	707.25	1.81	2.31	27.62	18.74	0.61	0.59
Dausa	584.84	1.49	1.14	–23.49	22.42	2.68	2.40
Dholpur	376.96	0.96	0.74	–22.92	21.12	2.58	2.30
Dungarpur	668.65	1.71	0.52	–69.59	19.35	5.17	4.08
Ganganagar	869.95	2.22	2.73	22.97	6213.93	1.19	1.19
Hanumangarh	765.25	1.96	3.26	66.33	201.38	0.94	0.94
Jaipur	1570.23	4.01	2.50	–37.66	20.37	2.46	2.19
Jaisalmer	798.26	2.04	2.64	29.41	7.68	1.39	1.18
Jalore	853.33	2.18	0.98	–55.05	17.99	1.29	1.20
Jhalawar	698.86	1.79	0.93	–48.04	14.40	2.16	1.88
Jhunjhunu	660.72	1.69	1.50	–11.24	16.72	1.56	1.43
Jodhpur	1233.48	3.15	2.16	–31.43	10.11	1.00	0.91
Karauli	567.09	1.45	1.16	–20.00	18.36	2.93	2.52
Kota	461.74	1.18	1.00	–15.25	32.27	1.71	1.62
Nagaur	1211.03	3.09	2.31	–25.24	16.77	0.96	0.91
Pali	904.53	2.31	1.09	–52.81	9.94	1.49	1.29
Rajsamand	565.37	1.44	0.64	–55.56	9.83	5.88	3.68
Sawaimadhopur	444.14	1.13	0.78	–30.97	18.05	1.67	1.53
Sikar	990.79	2.53	1.77	–30.04	24.41	1.89	1.75
Sirohi	437.28	1.12	0.55	–50.89	13.11	2.76	2.28
Tonk	624.45	1.60	0.81	–49.38	14.78	1.42	1.29
Udaipur	1491.78	3.81	1.55	–59.32	17.24	5.84	4.36
Rajasthan	26851.33	68.61	51.54	–24.88	15.84	1.57	1.43

estimated 1.26 ACU/ha (Dev *et al.* 2006). The livestock population pressure was highest in southern and eastern as compared to western and northern western districts.

The paper has estimated the livestock feed and fodder demand, supply and gap across different districts of Rajasthan. The study estimated the annual feed availability of 51.54 million tonnes against the requirement of 68.61 million ton thereby deficit of 24.87% per annum. Almost all the districts were facing the deficit except of five western and north western districts namely Hanumangarh, Bikaner, Jaisalmer, Churu and Ganganagar. Nearly half (46%) of the feed was contributed by crop residues which are having low nutritive value. The roughage concentration ratio was very low (1:0.06) in the state and it was less than state average for more than half of the districts mainly falling in western and southern part of the state. The overall pressure on feed resources (both grazing lands and net area sown) in the state as a whole was worked out to be very high at 1.43 ACU/ha with wide inter-district variability. The stocking rate in terms of 15.81 ACUs/ha of pasture and grazing indicates that subsistence on these resources are subjected to heavy stress as a result of poor quality herbages on CPR

land, especially in arid and semi-arid areas. There is a need to develop silvi-pastoral model by integrating grasses and fodder trees, particularly in southern districts, creation of fodder banks/ storage facilities in partnership with user groups, strengthening extension system and to develop a mechanism of participatory management of CPRs. Though varieties of fodder crops are available, there is a need to develop drought resistant and high yielding variety suitable for cultivation on agricultural lands or crop varieties with fodder component needs emphasis.

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