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Research article

Role of traditional feeding practices in solving forage inadequacy issue in sub-mountainous Punjab, India

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Abstract

An on-farm study was conducted to record the role of traditional livestock feeding practices, particularly the role of tree leaves in fulfilling the fodder requirement of dairy animals in 'low-input and low-output' systems of sub mountainous zone of Indian Punjab. Findings of the study were based on primary data of mixed farms equally spread over different farm size groups of randomly selected district Hoshiarpur from sub-mountainous zone of Punjab state. The study highlighted that the supplementation of tree leaves in addition to cultivated fodder helped the small and medium farmers to attain the adequacy of green fodder. During the summer season, tree leaves, on an average, improved the green forage DM availability at small farms by 128.0% (1.89 to 4.31 kg/d/ACU) and at medium farms by 70.6% (2.69 to 4.59 kg/d/ACU). In the winter season, the corresponding percentage for small and medium farms stood at 112.8 and 76.0%, respectively. The study further enunciated that fodder utilization/ACU on fresh basis was statistically higher in large farms, while in terms of dry matter (DM), fodder utilization was statistically at par for all selected landholding categories. Following the traditional practice of supplementing tree leaves with cultivated fodder (scenario 2), the proportion of farms (irrespective of size) with adequate fodder was recorded at 62.2% in summer season and 88.9% in winter season in comparison to 26.7 and 40.0% in hypothetical case of relying only on cultivated fodders (scenario 1).

Keywords: Forage adequacy, Nutritional requirement, Sub-mountainous zone, Traditional feeding practices

Introduction

In India, trees and forest greens have been playing an important role in livestock feeding and till date act as a pillar of several traditional livestock farming systems (Mishra *et al*., 2010; Mukherjee *et al.,* 2018). This system has seen a very long historic trajectory of co-evolution between trees and livestock (Biradar *et al*., 2007). Trees, being conservation-oriented, are crucial for protecting the environment including soil fertility. Punjab, the harbinger of green revolution is known for its livestock sector potential (Kashish and Kataria, 2020). The state, although small in size, has varied characteristics in terms of cropping pattern, soil type, water table, underground water quality and rainfall, etc. necessitating partitioning into different agro-climatic zones. The sub mountainous zone, popularly recognized as *Kandi* belt, extended in the north eastern border running along Shiwalik foothills of the state, accounts for nearly 17% of Punjab's total area and is spread over 4.53 lakh hectares (Rana, 2016). Due to the widespread heterogeneity in the agro-climatic conditions of this region, the cropping pattern of this zone is more diverse relative to other zones of the state. This part of the state has always been under-privileged as regards the available resources like assured irrigation leading to acute shortage of cultivated green forages. In spite of the significant role played by livestock sector in the economy of the region, its productivity has remained low due to shortage of feed and fodder, mainly because of limited area under fodder cultivation. The food and livestock production systems of this area can best be described as low-input and low-output system. Moreover, majority of the farmers in this semi-hilly arid zone are marginal and small holders, with limited means to feed their animals the required quantity, what to talk of quality feed (Bakshi and Wadhwa, 2004; Hundal *et al*., 2009). Majority of the livestock in this region are dependent on forest grasses and tree leaves (Bakshi *et al*., 2011). Against this backdrop, the present study was conceptualized to examine the role of tree leaves in fulfilling the

nutritional requirement of dairy animals as characterized by different seasons and farm size in sub-mountainous zone of Punjab.

Materials and Methods

***Sample selection*:** The present study was based on primary data of mixed farms (those in which more than 10% of the dry matter fed to livestock comes from crop by-products; FAO, 2010) of randomly selected district Hoshiarpur from sub-mountainous zone of Punjab state following the four stage sampling technique (Table 1). The data for the study culminated in the year 2020, were collected from 45 mixed farms equally spread over small (less than 5 acres), medium (5-10 acres) and large (greater than 10 acres) farm size groups, through a specially structured interview schedule.

In order to reasonably infer the results, the varied dairy animals were transformed into standard animal units (SAU), synonymously known as adult cattle units (ACUs). The ACUs were converted as per the methodology given by Ramachandra *et al*. (2007). The fodder availability was estimated for three different seasons *i.e*., summer (≃120 days of March, April, May, June), rainy (≃90 days of July, August, September) and winter (≃150 days of October, November, December, January, February) season. The feed and fodder requirement were calculated on the basis of standard adult cattle unit (ACU) of 350 kg body weight by assuming dry matter (DM) intake of 7.5 kg/day/ACU (Dikshit and Birthal, 2010). The total DM requirement was calculated, considering that ration must constitute 1/3 of concentrate and 2/3 of roughages (33:67), with dry and green fodder in the ratio of 20: 80. The DM transforms of available fodder types were culled from *Feedipedia (Animal feed resources information system).*

***Statistical analysis*:** For meaningful presentation of the results and to facilitate comparison, the data were presented by way of descriptive statistics in the form of tables and graphs. The Analysis of Variance techniques was used for ascertaining the statistical significance of season and farm size group-wise differentials with respect to study variables.

Results and Discussion

***Land use pattern and herd size*:** In the study sample, the net sown area (NSA) irrespective of farm size category was 7.47 acre and gross cropped area (GCA) was 15.21 acre translating into the cropping intensity of 203.65 (Table 2). The large farmers of this region had the lowest cropping intensity (202.4%) although it was comparable to that observed by medium farmers (204.3%). Another revelation of the study, was that the cropping intensity in case of small farms was the highest among all the farm size groups, with the value being 209.1%. The herd size irrespective of farm size groups was 3.33 ACUs per

Table 1. Details of four stage sampling technique

Stage I District (1)*	Stage II Block (1)*	Stage III Villages (3)*	Stage IV Mixed farms (45)*		
Hoshiarpur	Talwara	Changarwan	Small@ (5)	Medium# (5)	Large$ (5)
		Narangpur	Small (5)	Medium (5)	Large (5)
		BehLakhan	Small (5)	Medium (5)	Large (5)

*Number selected; @Small (<5 acres); #Medium (5-10 acres); $Large (>10 acres)

Table 2. Land use pattern and herd size details of sampled farms in sub-mountainous zone of Punjab

Particulars	Small (n_1: 15)	Medium (n_2: 15)	Large (n_3: 15)	Overall (N= 45)
Land use pattern				
Net sown area (acre)	2.53	6.57	13.30	7.47
Gross cropped area (acre)	5.29	13.42	26.92	15.21
Cropping intensity (%)	209.1	204.3	202.4	203.6
Herd composition (ACUs)				
Buffalo, No. (%)	1.86 (60.4)	1.44 (46.8)	1.96 (51.0)	1.75 (52.6)
Crossbred cattle, No. (%)	0.89 (28.9)	1.21 (39.3)	1.68 (43.8)	1.26 (37.8)
Indigenous cattle, No. (%)	0.33 (10.7)	0.43 (13.9)	0.20 (5.2)	0.32 (9.6)
Total herd size	3.08	3.08	3.84	3.33

farm with proportion of buffalo being the highest (52.6%), followed by crossbred cattle (37.8%) and indigenous cattle 9.6%. The preference for buffalo over crossbred cattle could be attributed to relatively higher maintenance cost in the case of crossbred cattle. The proportion of indigenous cattle was the highest in case of sub-mountainous zone in comparison to central plain zone and south western zone of Punjab. The herd size in terms of ACUs was similar for both the small and medium farms (3.08 ACUs), whereas it was 3.84 ACUs in the case of large farms.

***Fodder cultivation*:** Green fodder crops help in economizing the cost of milk production by providing less expensive source of nutrients in sharp contrast to concentrates and thereby paving the way for sustained profitability (Singh and Kataria, 2017). It was observed that fodder maize and pearl millet were the major *kharif* fodder crops of sub-mountainous zone of Punjab (Table 3). As regards to pearl millet cultivation, all the small farmers in comparison to 60% of medium and 80% of large ones had opted for it and the area apportioned was recorded at 0.29, 0.18 and 0.41 acre, respectively. None of the small farmers cultivated the maize crop during the *kharif* season and it was cultivated on an area of 0.15 and 0.12 acres by medium and large farmers, respectively. Berseem, the prominent fodder crop during *rabi* season, was cultivated by only 6% of small farms and 40% of medium farms and 93% of large farms on an area of 0.01 acre in the case of small, 0.18 acre in medium and 0.48 acre in large farms. Considering the entire sample, the fodder area during *rabi* season was observed as 0.22 acre, which was relatively less as compared to that observed in case of *kharif* season (0.38 acre). Moreover, the proportion of land area apportioned to fodder crops was the lowest (0.40%) in case of small farms compared to their counterparts with larger holdings, much in contrast to the situation in *kharif* and *zaid* season, wherein smaller farmers had to grow fodder crops on close to one tenth of the land area to sustain the livestock. The plausible reason for this phenomenon was the abundance of tree leaves during the *rabi* season, which gave the farmers leeway to forego fodder crop for wheat crop. The fodder area in case of large farms remained more or less the same in *kharif* and *rabi* season (0.53 *vs* 0.48 acre/farm), however, a conspicuous difference was recorded in case of small (0.29 *vs* 0.01 acre/farm) and medium farms (0.33 *vs* 0.18).

***Green fodder production and availability*:** It was observed that the selected farmers in the study area cultivated maize, pearl millet, sorghum and berseem

Table 3. Details of fodder cultivation in sub-mountainous zone of Punjab

Season	Crops		Small (n_1: 15)	Medium (n_2: 15)	Large (n_3: 15)	Overall (N= 45)
Kharif	Maize	(% of farmers)	-	40	20	20
		(Area, acre/farm)	-	0.15	0.12	0.09
	Pearl millet		0.29	0.18	0.41	0.29
	Total		0.29	0.33	0.53	0.38
	% of NSA		11.46	5.02	3.98	5.09
Zaid	Maize		0.03	-	-	0.01
	Pearl millet		-	0.08	0.12	0.06
	Sorghum		0.20	0.20	0.20	0.20
	Total		0.23	0.28	0.32	0.27
	% of NSA		9.09	4.26	2.41	3.61
Rabi	Berseem	(% of farmers)	6	40	93	47
		(Area, acre/farm)	0.01	0.18	0.48	0.22
	Oat		-	-	-	-
	Total		0.01	0.18	0.48	0.22
	% of NSA		0.40	2.74	3.61	2.95
Total fodder area			0.53	0.79	1.33	0.87
% of GCA			10.02	5.89	4.94	5.72

NSA: Net sown area; GCA: Gross cropped area

fodder. Since the entire quantity of fodder produced was not consumed at home, the quantity actually available to the animals at farm assumed greater importance especially when the fodder availability and nutritional requirement of the animals at the farm level was studied. The information pertaining to total green fodder production and availability of fodder crops at the selected farms was recorded (Table 4).

On an overall basis, the annual green fodder production was estimated at 251.1 q per farm. On an average, the corresponding figure recorded at 390.9 q in case of large farmers, 217.1 q in case of medium farmers and 145.4 q in case of small farmers. A closer scrutiny of the figures revealed that berseem fodder contributed 34% to the total fodder production followed by peal millet (32.8%), sorghum (25.5%) and maize (8.0%). The quantity of green fodder available with the farmers, net sale of 16.1 q per farm to fellow farmers was recorded at 235.0 q per farm. As it was expected, the farm size-wise availability of green fodder was found higher in case of large farms of sub-mountainous zone. The green fodder availability was 131.1 q per farm in case of small farms, 200.8 q per farm in case of medium farms and 373.3 q per farm in case of large farms. The proportion of quantity of fodder sold being the highest for small (9.8%), followed by medium (7.5%) and large (4.5%) farmers.

***Season-wise utilisation of fodder resources*:** Due to predominance of forest land in sub-mountainous zone, farmers generally harvest tree leaves from the nearby forest area for the purpose of supplementing animals in addition to farm produced green fodder. Comparatively lesser urbanization and more forest cover in this part of the state was found to be a boon to livestock economy thereof as tree leaves play important role to fulfil the fodder requirements of the ruminants. As per the general practice, the leaves of *Kali sirih* (*Albizia* spp), *Thamman* (*Grewia* spp), Mulberry (*Melia* spp) and *bamboo* (*Bambuso* ideae spp) trees were used for feeding purposes (Garg and Singh, 2011). The estimation of tree leaves made available to the livestock was done by relying on the judgement of the respondents.

At the overall level, green fodder availability inclusive of tree leaves at fresh basis in sub-mountainous zone was recorded as 272.2 q per farm, with large farms being bestowed with the maximum quantity (373.3 q per farm), followed by medium (246.3 q) and small farms (197.0 q) (Table 5).The utilisation of tree leaves on fresh basis was 14.9 q per farm during summer season, the corresponding values during the winter season being 22.3 q, accounting for one sixth of green forage utilised at the farm level. It was observed that annual consumption of tree leaves was 65.9 q in case of small farms and 45.5 q in case of medium farms. The utilization of tree leaves as fodder was specific to small and medium farmers and more so in summer and winter seasons. The annual availability of fodder resources on DM basis was to the tune of 53.5 q in case of small farms and 55.2 q in case of medium, the proportion of tree leaves in total green fodder consumption being higher in case of small farms (33.4 %) in comparison to medium ones (19.0 %). On an overall basis, the contribution of tree leaves to green fodder uptake (DM basis) stood at 30.2% in summer and 28.9% in winter season.

Table 4. Green fodder production and availability (per farm basis) in sub-mountainous zone of Punjab

Crops	Small (n_1: 15)	Medium (n_2: 15)	Large (n_3: 15)	Overall (N= 45)
Production (q/farm)				
Pearl millet	67.9	62.2	117.3	82.4
Sorghum	63.0	57.6	71.5	64.0
Maize	11.2	29.5	19.8	20.2
Berseem	3.3	67.8	182.3	84.5
Total	**145.4**	**217.1**	**390.9**	**251.1**
Availability* (q/farm)				
Pearl millet	64.1	60.2	108.5	77.6
Sorghum	54.7	43.3	65.9	54.6
Maize	9.0	29.5	19.8	19.4
Berseem	3.3	67.8	179.1	83.4
Total	**131.1**	**200.8**	**373.3**	**235.0**

*Net sale; 10 quintals (q) = 1 ton

The quantum of fodder utilized per ACU on fresh basis in case of small farms recorded at 64.0 q/ACU/annum was significantly lower (P<0.05) than that in case of medium (80.0 q) and large (97.2 q) farms (Table 6). However, on DM basis, all the three farm size groups were statistically (P<0.05) at par, the corresponding values (irrespective of farm size) being 17.4, 17.9, 17.3 q/ACU/annum for small, medium and large farms, respectively belying the general perception that smaller farms were at a disadvantageous position in terms of livestock fodder resources. The plausible reason was the high DM content of tree leaves (in comparison to commonly cultivated fodders), which traditionally formed a significant proportion of the livestock feed in sub-mountainous zone.

***Role of traditional practices in nutritional adequacy status*:** The present study conclusively established that green fodder availability was severely marred by the seasonal effect. This showed the role of supplementation of tree leaves in tiding over the gap between the normal requirement of green forage and its availability in study zone of Punjab. The cultivated fodder use (irrespective of farm size groups) on DM basis was observed to be statistically (P<0.05) lower in summer season (2.90 kg/d/ACU) than that in case of winter (3.62 kg/d/ACU) and rainy season (4.75 kg/d/ACU) and nutritionally inadequate (*i.e.*, <4.02 kg DM/ACU) in both summer and winter season (Table 7). With the supplementation of tree leaves, the corresponding DM availability was statistically (P<0.05) higher in

Table 5. Season wise utilization of green fodder resources (q/farm) in sub-mountainous zone of Punjab

Particulars	Small (n_1: 15)		Medium (n_2: 15)		Large (n_3: 15)		Overall (N= 45)	
	Fresh	DM	Fresh	DM	Fresh	DM	Fresh	DM
Summer								
Cultivated fodder	35.3	6.8	63.0	10.6	121.0	18.5	73.1	12.0
Tree leaves	26.3	9.3	18.2	6.4	-	-	14.9	5.2
CF+TL	61.6	16.1	81.2	17.0	121.0	18.5	88.0	17.2
Rainy								
Cultivated fodder	53.8	12.2	56.3	12.6	81.2	17.9	63.7	14.2
Tree leaves	-	-	-	-	-	-	-	-
CF+TL	53.8	12.2	56.3	12.6	81.2	17.9	63.7	14.2
Winter								
Cultivated fodder	42.0	11.3	81.5	16.0	171.1	30.1	98.2	19.1
Tree leaves	39.6	13.9	27.3	9.6	-	-	22.3	7.8
CF+TL	81.6	25.2	108.8	25.6	171.1	30.1	120.5	27.0
Total availability								
Cultivated fodder	131.1	30.3	200.8	39.2	373.3	66.6	235.0	45.4
Tree leaves	65.9	23.2	45.5	16.0	-	-	37.2	13.1
CF+TL	197.0	53.5	246.3	55.2	373.3	66.6	272.2	58.4

CF: Cultivated fodder; TL: Tree leaves; 10 quintals (q) = 1 ton

Table 6. Differences in fodder utilization (q/ACU/annum) of the selected farms

Particulars	Fresh basis*	DM basis*
Small (n_1: 15)	64.0^{y}	17.4^{a}
Medium (n_2: 15)	80.0^{x}	17.9^{a}
Large (n_3: 15)	97.2^{x}	17.3^{a}
Overall (N= 45)	81.7	17.6

*Inclusive of tree leaves; ^{xy}Values with different superscripts in a column differed significantly (P<0.05);
^{a}Values with same superscripts in a column did not differ significantly

winter season (5.35 kg) in comparison to both rainy (4.75 kg) and summer (4.34 kg) season. The supplementation of tree leaves to the cultivated fodder improved the availability scenario by 49.6 and 47.8% in summer and winter seasons, respectively. In fact, the supplementation of tree leaves with cultivated fodder helped the small and medium farmers to attain the nutritional adequacy of green fodder. During the summer season, the tree leaves, on an average, improved the green forage DM availability at small farms by 128.0 % (1.89 to 4.31 kg/d/ACU) and at medium farms by 70.6% (2.69 to 4.59 kg/d/ACU). In winter season, the corresponding values for small and medium farms stood at 112.8 and 76.0%, respectively.

An effort was made to ascertain the proportion of farms that exhibited nutritional adequacy with reference to the yardstick of normative value of 4.02 kg DM/d/ACU for green forage (Table 8). A simultaneous perusal of both the scenarios revealed that with the inclusion of tree leaves, as many as 66.7% of the small farms during summer season and of 93.3% during winter could achieve green fodder adequacy. Similarly, adequacy status of medium farmers improved from 20 to 60% in summer season and 26.7 to 80% in winter season. Following the traditional practice of feeding tree leaves, the proportion of the farms (irrespective of size) with adequate fodder was increased by 35.5% in summer season, while it was increased by 40.9% in winter season. None of the large farmers had used tree leaves during any of the season as they were probably able to fulfill their requirements by apportioning sizeable area to fodder crops.

Indeed, fodder trees as a potential feed resource was reported earlier in developing countries (Palsaniya *et al*., 2010; Arturi *et al*., 2014; Chauhan *et al*., 2019; Singh *et al*., 2021). Tree leaves as supplementary feed could well be recommended in areas with few or no alternatives available (Babayemi and Bamikole,

Table 7. Season wise fodder utilization (kg/d/ACU) in sub-mountainous zone of Punjab

Particulars	Summer	Rainy	Winter
Scenario 1: Cultivated fodder (DM basis)			
Small (n_1: 15)	1.89^b	4.52^a	2.57^b
Medium (n_2: 15)	2.69^b	4.47^a	3.00^b
Large (n_3: 15)	4.12^b	5.27^a	5.30^a
Overall (N= 45)	2.90^b	4.75^a	3.62^b
Scenario 2: Cultivated fodder + Tree leaves (DM basis)			
Small (n_1: 15)	4.31^b	4.52^b	5.47^a
Medium (n_2: 15)	4.59^b	4.47^b	5.28^a
Large (n_3: 15)	4.12^b	5.27^a	5.30^a
Overall (N= 45)	4.34^c	4.75^b	5.35^a

Values in bold connoted nutritional adequacy of green fodder w.r.t normative value of 4.02 kg DM/d/ACU; Values with different superscripts in a row differed significantly (P<0.05)

Table 8. Proportion (%) of farms with green fodder adequacy status in sub-mountainous zone of Punjab

Particulars	Summer	Rainy	Winter
Scenario 1: Cultivated fodder			
Small (n_1: 15)	-	53.3	-
Medium (n_2: 15)	20.0	73.3	26.7
Large (n_3: 15)	60.0	80.0	93.3
Overall (N= 45)	26.7	68.9	40.0
Scenario 2: Cultivated fodder + Tree leaves			
Small (n_1: 15)	66.7	53.3	93.3
Medium (n_2: 15)	60.0	73.3	80.0
Large (n_3: 15)	60.0	80.0	93.3
Overall (N= 45)	62.2	68.9	88.9

2006; Katoch, 2009; 2019), particularly to economize the feeding costs of animals reared by marginal and small land holders (Chander *et al.,* 2007; Njarui *et al.,* 2011; Gaikwad *et al*., 2017).

Conclusion

The majority of the small and medium farmers were found to be totally dependent upon tree leaves during the *rabi* season. The traditional practice of using tree leaves helped in tiding over the seasonal deficiency of cultivated fodders. The contribution of tree leaves to total green fodder uptake (DM basis) was 30.2 and 28.9% in summer and winter seasons, respectively contrasted to 'naught' during the fodder abundant rainy season. The livestock rearing pattern of sub-mountainous zone of Punjab indicated a peculiar form of crop livestock synergy, where natural flora and fauna relieved the burden on land resources available at farm level for its better utilization through other crops.

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