Research Article

PROTEIN DEFICIENCY – A CHALLENGE TO LIVESTOCK PRODUCTIVITY ENHANCEMENT IN NEPAL

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ABSTRACT

An assessment was made in 2019 to determine the crude protein (CP) supply situation for the livestock in Nepal. The land resources were assessed by utilizing the land use data generated by ICIMOD in 2010. The Land Resource Mapping Project (LRMP) (1986) remained the main source of data to estimate the CP supplies from these land resources (forests, shrub lands, grasslands, croplands, including weeds, and barren lands), plus kitchen wastes as animal feeds. Crop data of the Ministry of Agriculture and Livestock Development (MoALD) (2016/17) were utilized to estimate the CP supply from crop residues and milling by-products and the livestock data to estimate livestock feed requirements. The study findings revealed that there is critical shortage of CP in the livestock feeds across the eco-zones and across the provinces, with an overall deficit of 52.8%. The shortage reached about 60% in Province One and Three. The deficit in other provinces ranged from 37.6% to 52.6%. These deficits are mainly associated with the dependency of livestock production system on crop residues and low quality roughages. It is recommended that the future livestock development strategy focuses at encouraging farmers to replace the use of straws and stovers with improved forage or pasture and tree fodders. Likewise promotion of commercial silage production and development of productive partnerships with the feed millers for adequate production and supply of major imported poultry feed ingredients such as yellow maize and soybean are also important to consider.

Key words: Livestock Units, feed balance, ecological belts, province and land leasing

INTRODUCTION

Livestock is increasingly valued in Nepal for food security and youth employment. There are 7.3 million cattle, 5.2 million buffalo and 0.048 million yak/Chauries, 10.99 million goats, 0.8 million sheep, 1.3 million pigs, 0.056 million equines, 68.63 million fowl and 0.392 million ducks in the country (MoALD, 2017). A total of 2.53 million milking cattle and buffalo were producing 1.91 million t of fresh milk (65% buffalo milk). Buffalo also produced 180,080 t of meat annually. Small ruminants produced 70,420 t (95% goat) of meat annually. While the pigs produced 24,535 t of meat annually, poultry produced 57,509 t of meat (96% chicken) and 135 million eggs, annually. However, this sector also triggers the concerns of international community on climate change due to methane and carbon dioxide emission.

Singh & Singh (2019) reported that the deficit feed balance (TDN) at national level had dropped from 30.9% in the 1980's to 20.05% in 2016/17. By ecological belt, the feed deficit was the highest in the mid hills (-24.09%) followed by terai (-18.91%). Province One and Three were at severe situation of feed deficit at -30.48% and -38.44%, respectively. Feed deficit in the remaining provinces ranged from -9.19% to -15.85%, but there was a positive feed balance in Province Six (+6.35%).

Equally important element in livestock production is to understand the protein balance situation in the country. Deficiency in protein supply results in decreased performance in animal growth rate, milk production and reproductive performance. However, no systematic studies have taken place since the study done by Rajbhandary & Pradhan (1991) as the authors reported a protein deficit of 51.6%.Therefore, this study had been done to examine the protein balance situation of the country based on land use pattern, and crop and livestock production data as used by Singh & Singh (2019) while estimating TDN balance.

MATERIAL AND METHODS

Estimation of CP availability

Estimation of CP availability by land resources involved two-step analysis. Step one involved the analysis of land use data generated by the International Centre for Integrated Mountain Development (ICIMOD) in 2010 (http://rds.icimod.org) by employing geographic object-based image analysis (GEOBIA) using Lands at images. The ICIMOD data were clipped by using ArcGIS 10.4 version. The same algorithm was utilized to estimate land use and land cover (LULC) of each district, which were then congregated into provincial database. However, the above images did not provide data on feed productivity of any of these land resources, nor was there any detailed land productivity study carried out since LRMP (1986), except some spatial studies.

Therefore, the second step involved adoption of data generated by LRMP (1986), Devkota & Kolachhapati (2009 & 2011), and Miller (1993) for dry matter production from these land resources. The CP production by land resource was estimated by determining the average CP values (Table 1) for feeds obtained from each category of land resources based on the studies of Shrestha & Shrestha (1991), Dhaumadel & Tiwari (1992), Karki et al., (2000),https://books.google.com.np/books?isbn= 9251011281, Sep 15 2019. and https://assets.publishing.service.gov.uk/media/ …/R6994s.pdf. Sep 15 2019, which were further verified for common numbers by consulting the national experts. The CP contents of improved forage species were based on www.feedipedia.org.

Table 1. Average CP values of feeds, calculated based on different available sources

Eco-belts	Forest	Shrub lands	Grazing lands	Cultivated land	Barren land
High hills	11.5%	12.5%	10.5%	11%	6%
Mid hills	12.8%	12.5%	8.8%	11%	6%
Terai	12.3	12.5%	5.725%	11%	6%

Crop yields (production) data from MoALD statistics (2016/17) were used to estimate the CP supply from food crop residues and milling by-products based on their respective indices for harvesting and milling by-products based on critical review of national and international literatures as well as by personal communications with the national experts[1]. However, it must be recognized that the conversion factors vary by crop variety, agro-ecological differences, method of harvest and processing, and the method of data collection. These are the common limitations of such studies.

The CP supplied from straws was adjusted to the loss of straw due to burning on the field as well as its use in mushroom production. The annual burnt quantity was based on the data reported by Bhandari & Kafle (2017), and the annual use in mushroom production was based on the report of PACE Nepal Pvt. Ltd. (2012). Data on use of grains and by-products, molasses and import of feed ingredients by feed industries were obtained from the Feed Industries Association of Nepal (2017). Rural households customarily offer some grains and milling by-products to all types of livestock quite regularly. The offers vary by household economic condition and type and number of animals kept. Some assumptions are made in this study based on long working experience of the author in the rural areas. Generally, the milking cattle and buffaloes are offered one kilogram of concentrate (mainly cooked maize flour and rice bran) per two kilogram of milk. Use of oil seed cake is very minimal. The non-milking buffaloes are offered about 500g of concentrate per day per animal. These offers were accounted as supplemental CP supply at rural household level.

Similarly, goats are offered about 60g of concentrates per head per day, mainly maize or barley grain on average (HVAP, 2011). But in the terai, wheat bran makes up the major offer. It has been recognized that the local poultry and ducks obtain more than half of their required nutrients from scavenging, although maize and rice bran make up about half of their total energy requirements. Pigs are offered about 1.5kg of grain by-products per day per pig in general, mainly the rice bran and broken rice. Some improved pigs are raised on restaurant wastes, especially in the peri-urban areas. However, such numbers are too small to account in the national nutrient supply, hence has not been considered in the present analysis.

For equines, an average of 500gof barley (13% CP) is offered customarily to each adult animal as household allowance in the high hills, and gram (20% CP)in the mid hills and the terai. Supplemental feeding of draft oxen and male buffaloes were considered in their CP requirements as discussed below.

Estimation of CP requirements

CP requirements for cattle, and milk production, and for goats were adopted from NRC (2001) and University of Arkansas, USA (1914), respectively. CP requirement for maintenance of buffalo was estimated by 5.43g/kg$W^{(0.75)}$and for live weight gain, by 0.327g CP per g live weight gain as recommended by Paul et al. (2002) for Indian buffaloes. CP requirement for Yak and Chauries maintenance was estimated by- dry matter intake (kg/day/animal)=0.0165BW+0.0486 at 13.4% CP in the ration (Xue et al., 2007). Similarly, the maintenance CP requirement for sheep was estimated by CP requirement per day per animal = 6.98g/kg LW0.75 (Paul et al., 2003).

1 Harvesting indices of buckwheat from Dr. Binayak Rajbhandary, HICAST; rice from Mr. Bhola Man Singh Basnyat, Rice Production Expert; wheat, barley, millet from Dr. Madan Raj Bhatta, former National Wheat Production Coordinator; and pulse crops from Mr. Ram Krishna Neupane, ex-National Oil Seed Coordinator.

Requirements for draft animals were adopted from Oli (1984), and Sen (1978) and the requirement for equines were adopted from https://equi-analytical.com›nutrient-requirement-tables, 25 Sep 2019.

The figures for national/provincial meat production, CP required per unit live weight gain and dressing percentage as given in table 2 below were used to estimate the CP requirement for meat production from buffalo, mutton, goat and pork.

Table 2. Attributes utilized to estimate CP requirement for meat production

Species	National meat production, t	Dressing percentage	CP required per g live weight gain (g)
Buffalo	180,080	60	0.327*
Mutton	2,714	55	0.29
Goat	67,706	75	0.29
Pork	24,535	77	0.42

Source: *Paul et al. (2002) and Casey et al. (2003).

CP requirement for fish was estimated from total annual fish production, common feed ingredients used and feed conversion ratio of 2.0 under poly culture (Pradhan et al., 2012). Similarly, the CP required for poultry was estimated by converting the available CP in the annual amount of feed ingredients used by the feed industries (Feed Industries Association of Nepal, 2017).

RESULTS AND DISCUSSION

Changes in feed demand factors since 1986

Trend analysis of Ministry of Agriculture and Livestock Development (MoALD) data indicated that the poultry population increased by 118 times, pig population by 3.6 times, sheep and goat population by 2.1 times and cattle and buffalo population by 1.3 times in 2016/17 compared to 1980's. Similarly milk and meat production have increased by at least 2.5 times compared to 1980's.These increases had intensified the livestock feed demand dramatically (Singh, 2019).

Changes in supply factors

There has been significant increase in built up area (65.5%) and barren land (52.5%) since 1990 (Kabir et.al., (2018). Concurrently, the grassland area reduced by 26.8% and forest area by 7%, and the agricultural land increased by 7.6% and shrub land by 4.5%. The increased areas of agricultural and barren lands significantly increased the feed supply to the livestock compared to 1990 and before(Singh 2019).At the same time, the same author observed increase in cereal crop production at least by 2.15 times and the increase in average crop yields by 1.49 times for the same period, contributing to significant increase in supply of livestock feeds.

Sources of crude protein (CP)for the livestock feeds

Natural resources*:* Total crude protein (CP) available from the natural resources for the livestock was estimated 631.8 thousand t, of which the forest share alone was about half of the total supply (Table 3a). The crop weeds and grasses from the cultivated fields contributed about 25% of total CP, and the grasslands about 15%. The natural resources of the mid hills were the richest in CP availability, supplying 348.58 thousand t (55.2%).

Table 3a. Available CP by natural resource and eco-zone

Source	Available crude protein by eco-zone, '000t				Percent share
	High hills	Mid hills	Terai	Total	
Forest	13.62	224.90	73.18	311.69	49.3%
Shrub land	16.09	23.14	5.02	44.26	7.0%
Grassland	55.79	17.45	20.47	93.72	14.8%
Cultivated fields	15.16	76.50	67.45	159.11	25.2%
Barren lands	15.77	6.59	0.66	23.02	3.6%
Total	**116.43**	**348.58**	**166.79**	**631.79**	**100%**
Percent share	**18.4%**	**55.2%**	**26.4%**	**100.0%**	

Source: Author's estimate

All provinces, except Province Two had similar share in CP supply ranging between 14% and 17.2%. Province Two had the lowest share of 7.5% which was associated with smaller areas of natural resources available in this province compared to other provinces (Table 3b).

Table 3b. Available CP by natural resource and province

Source	Total CP Available ('000t) by Province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
Forest	52.79	14.05	55.49	40.97	55.54	39.2	53.63	311.7
Shrub land	8.01	1.43	2.75	9.88	4.48	11.15	6.56	44.26
Grassland	7.54	7.43	5.91	21.37	8.90	33.91	8.66	93.72
Cultivated fields	30.23	24.03	21.58	16.33	31.67	16.06	19.21	159.1
Barren lands	3.27	0.22	2.44	4.89	1.05	8.02	3.13	23.02
Total	101.8	47.15	88.16	93.44	101.7	108.4	91.18	631.8
Percent share	16.1	7.5	14.0	14.8	16.1	17.2	14.4	100.0

Source: Author's estimate

CP supply from crop residues/milling by-products: Total CP available from crop residues and milling by-products in the country was estimated at about570.4 thousand t (Table 4a). Rice straw and milling by-products had the largest share (44.4%) of CP, followed by wheat (23%) and maize stover (10.8%). Rest of the crops contributed less than 7%. By eco-zone, Terai obviously had the highest share of CP (60.4%) from these sources, followed by mid hills (35.2%). The high hills had the lowest share of only 4.4% (Table 4a).

Table 4a. CP available by crop residues and milling by-products by eco-zone

Crops	Eco-zone ('000 t)				CP share by crop
	High hills	Mid hills	Terai	Total	
Paddy	8.09	75.62	169.34	253.04	44.4%
Wheat	5.174	43.48	82.741	131.4	23.0%
Maize	5.26	45.07	11.404	61.74	10.8%
Mustard	0.36	7.81	26.372	34.54	6.1%
Lentil	0.06	0.78	18.685	19.52	3.4%
Sugarcane	0.02	0.09	18.982	19.09	3.3%
Millet	2.66	11.69	0.367	14.72	2.6%
Soy bean	1.23	10.34	0.867	12.44	2.2%
Sunflower	0.01	0.08	3.484	3.57	0.6%
Linseed	0.004	0.21	3.345	3.56	0.6%
Other legume	0.62	1.41	1.183	3.21	0.6%
Sarson	0.03	0.54	1.872	2.44	0.4%
Pigeon pea	0.001	0.07	2.193	2.26	0.4%
Black gram	0.29	1.32	0.301	1.91	0.3%
Barley	0.663	0.646	0.055	1.364	0.2%
Sesame	0.007	0.159	0.927	1.093	0.2%
Niger	0.014	0.371	0.403	0.787	0.1%
Buckwheat	0.413	0.236	0.093	0.743	0.1%
Rayo	0.007	0.408	0.310	0.726	0.1%
Chickpea	0.028	0.137	0.485	0.651	0.1%
Grass pea	-	0.014	0.588	0.602	0.1%
Groundnut	0.009	0.174	0.360	0.543	0.1%
Horse gram	0.043	0.303	0.108	0.454	0.1%
Total	24.98	200.95	344.46	570.39	100.0%
Percent share	4.4%	35.2%	60.4%	100.0%	

Source: Author's estimate

By province the CP supply from these sources was the highest in Province Two, followed by Province Five and Province One (Table 4b). The lowest CP supply was from Province Six followed by province Four. Province Three and Seven had similar share of about 12% to the national CP supply pool (Table 4b).

Table 4b. CP available by crop residues and milling products by Province

Crops	Total CP Available ('000t) by crop residues and milling by-products and by Province							Total
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	
Paddy	55.29	56.72	27.22	23.93	52.85	7.93	29.10	253.0
Wheat	12.60	36.25	11.90	6.60	32.00	11.43	20.62	131.4
Maize	17.74	3.23	14.27	10.31	8.43	5.09	2.66	61.7
Mustard	4.51	4.80	6.17	1.70	9.87	1.08	6.41	34.5
Lentil	1.23	6.93	0.58	0.47	7.25	0.26	2.80	19.5
Sugarcane	1.47	12.26	0.03	1.06	2.81	0.00	1.45	19.1
Millet	4.57	0.08	3.23	4.69	0.50	0.91	0.74	14.7
Soy bean	2.13	0.11	3.36	1.32	0.95	1.09	3.47	12.4
Sunflower	2.37	0.43	0.46	0.03	0.26	0.00	0.02	3.6
Linseed	1.02	1.76	0.03	0.14	0.51	-	0.09	3.6
Other legume	0.78	0.34	0.48	0.45	0.45	0.66	0.05	3.2
Sarson	0.17	0.76	0.32	0.39	0.76	0.02	0.02	2.4
Pigeon pea	0.16	1.34	0.02	0.03	0.68	0.01	0.02	2.3
Black gram	0.54	0.09	0.37	0.49	0.17	0.06	0.20	1.9
Barley	0.08	0.01	0.11	0.12	0.15	0.59	0.30	1.4
Sesame	0.11	0.32	0.35	0.02	0.16	0.02	0.12	1.1
Niger	0.33	0.05	0.39	0.01	0.01	0.00	-	0.8
Buckwheat	0.15	-	0.28	0.14	0.06	0.11	0.01	0.7
Rayo	0.17	0.26	0.17	0.10	0.02	0.00	0.01	0.7
Chickpea	0.05	0.16	0.04	0.02	0.23	0.07	0.07	0.7
Grass pea	0.05	0.15	0.00	0.01	0.37	0.01	0.01	0.6
Groundnut	0.02	0.02	0.05	0.02	0.37	0.05	0.01	0.5
Horse gram	0.18	0.05	0.04	0.07	0.03	0.02	0.06	0.5
Total	106	126	70	52	119	29	68	570.4
Percent share	18.5%	22.1%	12.3%	9.1%	20.8%	5.2%	12.0%	100.0%

Source: Author's estimate

Of CP supply by crop residues and milling by-products, 62% were from straws and the rest by milling by-products (Table 5). Rice and wheat straw, and maize stovers were the major crop residues contributing about 82% of CP supply from crop residues and 72% of CP supply from milling by-products (Table 5).

Table 5. CP supplies from crop straws and milling by-products

Details	Straw	Milling by-products	Total	Percent share of straw
Total CP supply	351.77	218.62	570	61.7%
Rice, wheat and maize stover	288	158	446	
Others	63.45	60.76	124	
Percent share of rice, wheat and maize crops to total crop CP supply	82%	72%		

Source: Author's estimate

CP supply from improved forage and pasture: Total CP available from the improved forage and pasture was about 118.7 thousand t, of which terai shared the highest portion (56.8%) of CP followed by the mid hills (Table 6a). The share of the high hills was only 6.4%, indicating that very little attention has been given to introduce improved forage and pasturesin the high hills compared to the terai and the mid hills. These differences in level of effort may be associated with the differences in the level of concentration of national dairy milk grid, limited connectivity and limited market access.

Table 6a. CP available from improved forage and pasture by eco-zone

Eco-zone	High hills	Mid hills	Terai	Total
Available CP, '000 t	7.65	43.66	67.40	118.71
Percent share	6.4%	36.8%	56.8%	100.0%

Source: Author's estimate

Table (6b) below indicates that CP availability from improved forage and pasture was highest in province Three followed by province One, Two and Four. Province Six, Seven and Five had the lowest share, indicating that these provinces received lesser attention for forage and pasture development compared to other provinces (Table 6b).

Table 6b. CP available from improved forage and pasture by province

	CP available ('000 t) by Province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
Available CP, '000 t	23.00	22.73	29.69	18.35	13.13	5.76	6.05	118.7
Percent share	19.4%	19.1%	25.0%	15.5%	11.1%	4.9%	5.1%	100%

Source: Author's estimate

CP supply from other sources: In addition to the above supply sources, customary household (HH) allowances (feed offered by HHs on regular basis to farm animals and birds) contribute a significant portion of CP to the livestock feed. Other sources of supplies are feed ingredients imported by the feed industries, kitchen waste fed to livestock, particularly in the rural areas and the commercial silages. CP supplies by source are given in Table (7a).

In aggregate, these sources supply 507.2 thousand t of CP annually, of which about 49% is available in the terai and 46% in the mid hills. The share of high hills is only about 5%.

Table 7a. CP availability by other sources, by eco-zone

Source	Total CP Available ('000t)			
	High hills	Mid hills	Terai	Total
1. HH allowances for:	21.6	179.1	171.2	371.9
- Milk production @1.5kg/kg milk produced, in general	6.4	46.1	43.0	95.6
- Buffalo (500g per day per head) @11% CP	6.8	52.5	44.5	103.8
- Goats (60g per day per head)	0.003	0.013	0.009	0.024
- Local pigs (1.5kg per day per head)	3.6	20.5	14.9	38.9
- Local poultry (50% of 120 g per day per head) at 10% CP	4.7	59.1	66.6	130.5
- Local duck (50% of 140g/day per bird) @11% CP	0.1	0.9	2.2	3.2
2. CP import by feed industries	2.0	35.5	58.3	95.7
3. Commercial silage @40 MT/day, 7% CP	-	-	1.0	1.0
4. Kitchen wastes*	2.9	17.2	18.5	38.6
Total	26.5	231.7	249.0	507.2
Percent share	5.2%	45.7%	49.1%	100.0%

Source: Author's estimate

Similarly, province Three had the highest CP offer of about 33% (Table 7b). Province One and Five had similar offerings of about 16 to 17%. Province Seven had the least offer of about 6.8% of total CP from other sources (Table 7b).

Table 7b. CP availability by other sources, by province

Source	CP available ('000t) by Province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
HH allowance for:	72.5	46.4	104.4	40.6	62.4	16.2	29.3	371.9
- Milking animals @1.0kg feed/kg milk produced, in general	19.2	13.7	17.9	12.8	16.8	4.7	10.4	95.6
- Non-milking buffalo (500g per day per head) @11% CP	17.2	15.7	18.3	13.6	22.4	6.2	10.4	103.8
- Goats (60g per day per head)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
- Local adult pigs (1.5kg per day per head)	18.5	2.9	4.3	2.5	6.7	2.2	1.8	38.9
- Local poultry (50% of 120 g per day per head) at 11% CP	16.69	13.38	63.51	11.29	16.09	3.00	6.50	130.46
- Local duck (50% of 140g/ day per bird) @11% CP	0.86	0.79	0.41	0.45	0.51	0.09	0.11	3.21
CP import by feed industries	6.54	9.84	53.65	10.31	12.41	1.04	1.92	95.71
Commercial silage @40 MT/ day, 7% CP	-	1.02	-	-	-	-	-	1.02
Kitchen wastes*	7.15	6.83	8.82	3.91	6.40	2.06	3.40	38.57
Total	86.2	64.1	166.9	54.9	81.3	19.3	34.6	507.2
Percent share	17.0%	12.6%	32.9%	10.8%	16.0%	3.8%	6.8%	100.0%

Source: Author's estimate

Import of cereals and their by-products: In 2016/17, the poultry industries in Nepal used 745,429 t of feed ingredients, of which 75% yellow maize, 99% of soybean, 90% each of sesame and mustard cakesand 30% de-oiled rice bran were imported (Nepal Feed Industries Association, 2074 (2017). While the import of de-oiled rice bran and oil cakes were mainly due to short supplies in the country, the import of maize was mainly associated with the poor quality of local production (Singh, 2019). The CP value of these imported ingredients was about 95.7 thousand t. CP supply from kitchen wastes was about 38.57 thousand.

Overall CP supply by source

The overall CP available was estimated at 1732.39 thousand t, of which the natural resources contributed 36.5%, followed by crop residues and the milling by-products 32.9% and customary HH allowance 21.5%. The contribution of improved forage and pasture was only 6.9% (Table 8a).

Table 8a. Overall crude protein available by source and eco-zone

Source	Available crude protein by eco-zone, '000t				Percent share
	High hills	Mid hills	Terai	Total	
Natural resources	116.43	348.58	166.78	631.79	36.5%
Crop residues and milling products	24.98	200.95	344.46	570.39	32.9%
Improved forage and pasture	7.65	43.66	67.4	118.71	6.9%
HH allowances	21.6	179.1	171.2	371.9	21.5%
Commercial silage @40 MT/day, 7% CP	-	-	1	1	0.1%
Kitchen wastes*	2.9	17.2	18.5	38.6	2.2%
Total	173.56	789.49	769.34	1732.39	
Percent share	10.0%	45.6%	44.4%	100.0%	

Province One, Three and Five were similar for CP availability in aggregate with an average of about 17.5%. The lowest level of CP availability was observed in province Six (Table 8b).

Table 8b. Overall crude protein available by source and province

Source	Total CP Available ('000t) by Province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
Natural resources	101.84	47.16	88.17	93.44	101.64	108.36	91.19	631.8
Crop residues and milling products	106	126	70	52	119	29	68	570.4
Improved forage and pasture	23	22.73	29.69	18.35	13.13	5.76	6.05	118.7
HH allowance	72.52	46.44	104.42	40.63	62.44	16.16	29.29	371.9
Commercial silage @40 MT/day, 7% CP	-	1.02	-	-	-	-	-	1.02
Kitchen wastes*	7.15	6.83	8.82	3.91	6.4	2.06	3.4	38.57
Total	310.51	250.18	301.1	208.33	302.61	161.34	197.93	1732.39
Percent share	17.9%	14.4%	17.4%	12.0%	17.5%	9.3%	11.4%	100.0%

Estimated feed (crude protein) demand

Total CP demand of livestock in 2016/17 is estimated at 3570.9 thousand t (Table 9a). The large ruminants occupied about 68% of total CP requirement in the country. Of the large ruminants, the share of cattle was the highest followed by buffalo. These quantities also included the requirements for draft male animals and the breeding bulls. The share of small ruminants was only 8%, of which goat occupied 92% and the rest by sheep. Poultry occupied about 9% of the total demand and the pig 3.4% (Table 9a).

Table 9a. Crude Protein requirement by eco-zone and livestock species for 2016/17

Species	CP Requirement ('000t)				Percent share
	High hills	Mid hills	Terai	Total	
Cattle	140.08	616.16	603.96	1,360.20	38.10%
Buffalo	69.23	538.72	455.1	1,063.05	29.80%
Yak/Nak	0.92	0.17	-	1.09	0.03%
Goat	27.36	134.32	91.98	253.66	7.10%
Sheep	8.47	8.9	3.59	20.96	0.59%
Horse	11.99	11.03	1.62	24.64	0.69%
Pig	10.47	66.27	46.3	123.04	3.40%
Poultry	10.19	140.21	180.53	330.93	9.30%
Duck	0.1	0.93	2.18	3.21	0.09%
Fish	0.02	0.75	34.13	34.90	0.98%
Milk production	13.07	106.62	96.41	216.10	6.10%
Meat production	10.88	66.07	62.19	139.14	3.90%
Total	302.78	1690.15	1577.99	3570.92	100.0%

Source: Author's estimate

By province, the CP requirement was the highest in province One followed by province Three and Five (Table 8b). Province Six had the lowest CP requirement followed by province Four and Seven.

Table 9b. Crude protein requirement by province and livestock species

Species	CP Requirement ('000t) by province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
Cattle	364.7	199.7	195.4	99.8	209.0	114.9	176.6	1,360.2
Buffalo	176.8	160.2	186.9	138.7	229.8	63.3	107.3	1,063.0
Yak/Nak	0.3	-	0.2	0.2	-	0.3	0.0	1.1
Goat	52.5	32.5	49.0	26.4	45.2	23.2	24.8	253.7
Sheep	2.0	0.2	1.9	2.8	3.7	7.7	2.7	21.0
Horse	2.7	0.1	0.4	1.8	1.7	16.1	1.8	24.6
Pig	54.3	9.2	17.2	8.8	21.5	6.2	5.8	123.0
Poultry	35.3	34.0	169.8	31.1	41.6	6.2	13.0	330.9
Duck	0.9	0.8	0.4	0.4	0.5	0.1	0.1	3.2
Fish	4.4	19.8	1.9	0.2	7.7	0.0	0.9	34.9
Milk production	42.2	30.9	41.0	29.8	38.6	10.6	23.0	216.1
Quantity of meat production	28.9	19.8	24.9	15.9	26.9	9.1	13.6	139.1
Total	765.1	507.1	689.1	356.1	626.3	257.6	369.5	3,570.9
Share of province	21.4%	14.2%	19.3%	10.0%	17.5%	7.2%	10.3%	100.0%

Protein Balance

Based on the above analysis, it was found that the CP availability for livestock were critically negative across the eco-zone and across the province (Table 10a&b). The deficits were critical across the eco-zones and provinces. Overall CP deficit was 52.8%. This figure is similar to the figure (51.6%) reported by Rajbhandary & Pradhan (1991).

When considered the supply sources, crop residues and milling by-products constituted about one-third the total CP supply. Of these sources, crop residues comprised 62% of total CP supply. This indicates that the protein

deficiency would be even worse when examined for the digestible or metabolizable crude protein. This is an area for future study.

Table 10a. CP balance by eco-zone

Source	Available crude protein by eco-zone ('000t)			
	High hills	Mid hills	Terai	Total
Estimated total available CP (Table 8a)	173.56	789.49	769.34	1,732.39
Livestock requirement (Table 9a)	302.78	1,690.15	1,577.99	3,570.92
CP import by feed industries (Table 7a)	2	35.5	58.3	95.80
Total CP requirement	304.78	1,725.65	1,636.29	3,666.72
CP deficit	-131.22	-936.16	-866.95	-1,934.33
Percent deficit	-43.1%	-54.2%	-53.0%	-52.8%

Table 10b. CP balance by province

Source	Total CP Available (‘000t) by Province							
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	Total
Total available CP (Table 8b)	310.5	250.2	301.1	208.3	302.6	161.3	197.9	1732.4
Total livestock requirement (Table 9b) (x)	765.1	507.1	689.1	356.1	626.3	257.6	369.5	3,571
Import of CP for commercial poultry (Table 7b) (y)	6.5	9.8	53.7	10.3	12.4	1.04	1.9	96
Overall requirement (x+y)	771.7	517.0	742.7	366.4	638.7	258.7	371.5	3666.6
Total Deficit	-461.2	-266.8	-441.6	-158.1	-336.1	-97.4	-173.5	-1934.2
Percent deficit	-59.8	-51.6	-59.5	-43.1	-52.6	-37.6	-46.7	-52.8

CONCLUSION AND RECOMMENDATIONS

The findings of this study indicate that inadequate attention has been given to improve the quality of livestock feeds in Nepal. This has left farmers to depend their livestock farming mainly on crop residues. However, the inclusion of rice straw beyond 25% in dairy animal ration and 50% in the dry cow ration limits intake and hence animal production performance (Drake et al., 2002). This may be the reason that livestock productivity in Nepal is very low compared to the neighboring countries. The commercial sector is hit even worse making their products non-competitive perhaps due to low financial output per rupee investment. Secondly, the present crop residues-based feeding system is not climate friendly as it increases rumen methane production and contributes to global warming.

Therefore, it is recommended that the future livestock development strategy should focus at encouraging farmers to replace the use of straws and stovers with improved forage or pasture and fodder trees. In support of this strategy, greater attention is needed on: (a) increasing winter fodder production by double or triple cropping of appropriate species and varieties, and promotion of fodder tree blocks at Households (HH), or group level to supply protein during the winter and the dry summer; (b) promotion of commercial silage production; and (c) development of productive partnerships with the feed millers for adequate production and supply of major poultry feed ingredients such as yellow maize and soybean. In these processes, replacement of low producing animals with the high producing ones should be a parallel course of action.

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