

Animal Feed Resources and their Management in Nepal

Netra P Osti*

National Animal Science Research Institute (NASRI), Khumaltar, Nepal

***Corresponding Author:** Netra P Osti, National Animal Science Research Institute (NASRI), Khumaltar, Nepal.

Received: June 17, 2019; **Published:** December 05, 2019

DOI: 10.31080/ASAG.2020.04.737

Abstract

Nepal is an agriculture based country and livestock is an integral part of the Nepalese economy, contributing about 26 percent to the agricultural domestic products (AGDP). Livestock provide meat, milk, eggs for human nutrition; wool and hides for the industry and manure for crop production. Nepal has a large livestock population consisting of: cattle 7 million, buffaloes 5 million, goats 10 million, sheep 1 million, pigs 1 million and fowl 48 million. The buffalo population ranks 4th among buffalo rearing countries but their production is very low as compared with those in neighbouring countries such as India and Pakistan. The overall low production of livestock is mainly due to low supply of quality animal feeds and inefficient use of available feed resources. In order to rationally use the available feeds, their assessments and use were studied in three ecological belts and five development regions in Nepal. This study is based on review of various journals, conference proceedings, project reports, statistical data from the statistics department, expert opinion and analysis by the team members.

Livestock herd composition and sizes vary in the three ecological zones (mountains, hills and Terai). The majority of the livestock holdings are small (5-7 animals per household) in size. Among the ruminant animals, the buffalo population has increased from 4 to 5 million in the last ten years. Buffalo contribute approximately 72 percent of milk and 65 percent of domestic meat supply. Lime, Parkote and Gaddi buffaloes are native breeds, while Murrah and their crosses are the improved breed of buffalo in Nepal. The cattle population has remained stable (7 million) for the last decade and its contribution is 28 percent to the national milk supply. Shree, Pahadi, Khaila and Terai cattle are native while Jersey and Holstein are exotic breeds of cattle in Nepal. The sheep population has decreased from 0.82 to 0.81 million in the last ten years, while goat numbers are steadily increasing (from 7 to 10 million in the last decade). Among the non-ruminant livestock species chicken numbers increased considerably from 23 to 48 million in the last decade to supply eggs and meat to fast growing urban human population.

Extensive and semi-extensive livestock production systems exist in the mountain zone, and in the high altitude alpine regions transhumance grazing system is practiced where livestock are grazed on local pasture in foothills and forest during winter (November to March) and spend late spring and summer months (April to October) on high altitude pastures. In the hills, extensive and semi-intensive production systems are common while small numbers of animals are raised in intensive system. Tree fodder, grasses and legumes collected from forest and cultivated lands and rice straw are the major feeding resources in semi-intensive and extensive system in the hills of Nepal. Locally made semisolid (Kundo) from kitchen waste, and maize flour mixed with rice bran is given to productive animals during evenings. Livestock rearing in Terai resembles to that in hilly region with respect to extensive and semi-extensive production systems. Near to urban and semi-urban areas commercial livestock production exists to cater for the demand of urban populations.

Crop residues, rice and wheat straw, maize stovers, tree fodder, leaf litters and other green fodder collected from cultivated lands and forest are the major feeding resources in Nepal. In concentrate, maize is the main feed ingredient followed by rice bran, wheat bran, soybean meals, mustard cake, sunflower cake and other legumes by-products. Due to fast growing poultry and dairy farming, the local production of maize and soybean does not meet national feed demand and these are imported from India and other countries.

The native feed supply in Nepal is not adequate to meet the demand of existing livestock and poultry. There is a deficit of 33 percent in dry matter, 38 percent in crude protein and 42 percent in metabolizable energy. The human edible protein output per unit of human edible protein consumed by livestock is higher in ruminants, especially in sheep and goats, than in pigs and poultry. This demonstrates greater scope of ruminant livestock contribution to food security in Nepal with scarce feed resources.

Keywords: Animal Feeds; Nepal; Livestock; Farming

Introduction

Nepal is an agricultural based country with the typical crop livestock mixed farming system practiced in most of the country. Livestock is an integral part of the Nepalese farming system that contributes about 26 percent to the Agricultural Gross Domestic Products [1].

Livestock are kept for draught in agriculture, transport and manure besides being a major source of household income, cash and social security. Increased urbanization, improved mobility and the increased flow of tourists have increased the demand for livestock products which has led to increasing commercialization of live-

stock [2], especially in the Terai and near to urban areas. Almost all Nepalese farming families keep some animals; average livestock per family is about 4.8 head. With increasing altitude the number of livestock per household rises (3.1 and 12.2 head per family in Terai and Mountains, respectively). Animal output is very low, average milk production of indigenous cattle is 880 liters/cow/year, whereas for buffalo it is 1 158 liters/buffalo/year [3]. About 64 percent of buffaloes are local breeds producing only 600 litres per lactation compared to 960 – 1 200 liters for cross and improved ones [4,5]. Wool production is only 0.68 kg/sheep/year [3] and also in decreasing trends from last 10 years (Table 1).

Livestock Product	Year		Percent change in 10 years	Percent change/year
	2002-03	2012-13		
Milk (tonnes)	1,195,931	1,680,812	40.54	4.05
Cow	361,555	492,379	36.18	3.62
Buffalo	834,376	1,188,433	42.43	4.24
Meat (tonnes)	203,899	295,167	44.76	4.48
Buffalo	130,791	175,132	33.90	3.39
Sheep	2,792	2,721	-2.54	-0.25
Goat	39,664	55,578	40.12	4.01
Pig	15,626	18,709	19.73	1.97
Chicken	14,756	42,810	190.12	19.01
Duck	270	217	-19.63	-1.96
Eggs (000)	557,361	887,240	59.19	5.92
Wool (kg)	600,689	587,834	-2.14	-0.21

Table 1: Livestock production trends over the last 10 years.

Source: MOAD 2013 [1].

The tenth Five-Year Plan aims to achieve a production of 303 000 tonnes of meat and 1 540 000 tonnes of milk from the base year production of 203 000 tonnes and 1 154 000 tonnes, respectively. Accordingly its share in Agricultural Gross Domestic Product (AGDP) growth will rise from 31 percent to 45 percent. APP prioritizes the increase in milk and meat production, improvement of animal nutrition, health and marketing as key areas in livestock sector development [6]. The most important limiting factor to meet this challenging task is the feed and fodder deficit. Traditionally the major feed resources are crop residues and by-products, forest, seasonal grazing land, and non-cultivated areas. Agricultural lands provide about 60 percent of the total annual feed supply, mainly in the form of low quality crop residues, whilst 40 percent comes from forest and grazing lands [7]. The feed balance is such that the total dry matter deficit, and total green roughage deficit in the country is about 30.8 percent and 54.3 percent, respectively [8,9]. Livestock in Nepal are in feed deficit by over three million tonnes per annum [7]. Great efforts have to be made to provide adequate feed not only to increase production, but also to lower the production cost, but only limited options are available to tackle this problem.

In this context, the present paper describes the commonly available feeds and feeding situations focusing to ruminants and monogastric species mainly in the three ecological regions and five development regions in Nepal.

Approaches and methodology

The present report is based on the critical review of various types of literature including journal articles, online articles, annual progress reports of various agencies, institutions and organizations, statistical yearbooks of Nepal, text books, research reports, master and PhD theses etc. Tables and texts in this report are generated with the help of quantitative data available in the national statistics [1] and converted into desired indices (e.g. input-output ratios etc) by using appropriate conversion factors (Table 4), crop residues by appropriate harvest index/extraction ratios by using appropriate conversion unit (Habib 2014), along with available reviewed articles and reports. Available feeding materials are calculated on the basis of main products with harvest index/extraction ratios of crop residues, oil meals and by-products (Table 3) and grasses, fodder and other resources are calculated by available land resources and

estimated yield ratio (Table 4). Animal requirements are calculated by using livestock unit (LU) of different classes of animals by assuming 7 mt dry matter requirements per livestock unit per year.

The report attempts to provide detailed information regarding the feeds and feeding situation in different seasons (summer and winter) in three ecological regions (Mountain, Hills and Terai) of all five development regions (eastern, central, western, mid-western and far-western) for each livestock species including ruminants and non-ruminants reared in Nepal.

Information thus collected were verified and approved by organizing a day workshop with the key persons and professional experts from the Agriculture and Forestry University (AFU), Nepal

Agriculture Research Council (NARC) and Department of Livestock Services (DLS) in Kathmandu Nepal on 12 July, 2013.

Results

Herd structure

Nepalese livestock herd composition and size varies according to different ecological zones. The Majority of the livestock holdings are small (5-7 per household). Nepal comprises 7 million cattle, 5 million buffaloes, 0.81 million sheep, 10 million goats, 1.6 million pigs and 48 million fowl population (Table 2). Buffaloes goats and fowl population are rapidly increasing compared to other animals species due to the high demand of milk and meat products in urban areas. The sheep population is sharply decreasing due hardship lives in mountains, migration and low benefit from this business.

Category	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Cattle	6.99	7.00	7.04	7.09	7.18	7.20	7.23	7.24	7.27
Buffaloes	4.08	4.20	4.37	4.50	4.68	4.84	4.99	5.13	5.24
Sheep	0.82	0.81	0.81	0.81	0.80	0.80	0.81	0.81	0.81
Goats	7.15	7.42	7.85	8.14	8.47	8.84	9.19	9.51	9.79
Pigs	0.95	0.96	0.99	1.01	1.04	1.06	1.11	1.14	1.16
Fowl	22.79	23.22	23.92	24.67	24.48	25.76	39.53	45.17	47.96
Duck	0.39	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38
Milking cows	0.90	0.90	0.91	0.92	0.93	0.95	0.97	1.00	1.03
Milking buffalo	1.05	1.08	1.12	1.16	1.21	1.25	1.29	1.33	1.37
Laying hens	6.64	6.77	6.96	7.15	7.12	7.29	7.48	7.91	8.23
Laying ducks	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.17	0.17
Yak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Rabbits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

Table 2: Nepal’s livestock populations (million head) over the past 10 years.

Source: MOAD 2013.

Ruminants

Major ruminant livestock species include cattle, buffaloes, sheep and goats (Table 2). Buffalo population has been increasing (3.65%/year) over the last ten years due to its dual purposes as milk and meat. Buffalo milk has very good taste and has high fat contents as compared with cow milk and contributes 72 percent in national milk supply. It has been reported that around 50% of all households keep at least one milking buffalo for home consumption of milk. Likewise buffalo meat is very popular due to its leanness and delicacy and contributes 65 percent in national meat supply. There are local as well as improved breeds of buffaloes in Nepal, Lime, Parkote, Gaddi are local breeds while Murrah and crosses with local breeds predominantly found in Terai and road assessable areas where milk markets are good. Goats are also fast growing (4.91%/year) livestock species. Goat meat is preferred

and fetches a higher price as compared to meat from other animals. Jamunapari, Barbari, Boar are improved goats (exotic) while Khari, Terai, Sinhal and Chyangra are local goat breeds. In high mountain areas, Chyangra goats that produce fine Pashmina hair are common. Cattle include both exotic and indigenous breeds. The exotic breeds include Jersey, Holstein Friesian, and Brown Swiss while indigenous breeds are Siri, Pahadi, Khaila, Achhami. Indigenous cattle are low milk producers but are largely valued for tilling land (oxen source) as well as providing dung as a source of manure and household fuel. Yak, Nak and Churies (crosses with local cattle) are predominantly kept in northern part of Nepal. They are kept near homes during winter due to heavy snow fall during winter months and are freely grazed during the summer and rainy season. Yak are used for transportation of loads, ploughing lands while Nak and Chauries used for milk to make cheese and churpi (dry paneer).

Non-ruminants (monogastrics)

Pigs and poultry birds are dominating non-ruminant commodities in Nepal. Poultry production in semi-urban areas and peri-urban areas has been growing fast (7.76%/year) during the last ten years. Poultry keeping is commercialized in Nepal and fully meets the country's demand [10]. Pig rearing, including both indigenous and exotic breeds, plays crucial role in religious norms as well as adding to food security of the rural people. Horses are specifically popular in the high mountains where asses and mules are also important species for draft and carrying loads in mountain areas (Table 2). Rabbit keeping was introduced with UK assistance in eastern and western Nepal for wool and meat purposes. A small number of government and private farms are keeping rabbits but their number did not increase due to predators and limited preference for rabbit meat. Angora rabbits were popular in the past but recently their number rapidly declined due to uncertain market for the fur.

Livestock production systems

Nepal comprises three distinct ecological zones; high mountain in the north, hills in the middle and flat Terai in southern part of the country (Figure 1). Each ecological zone has peculiar livestock production systems which are given below.

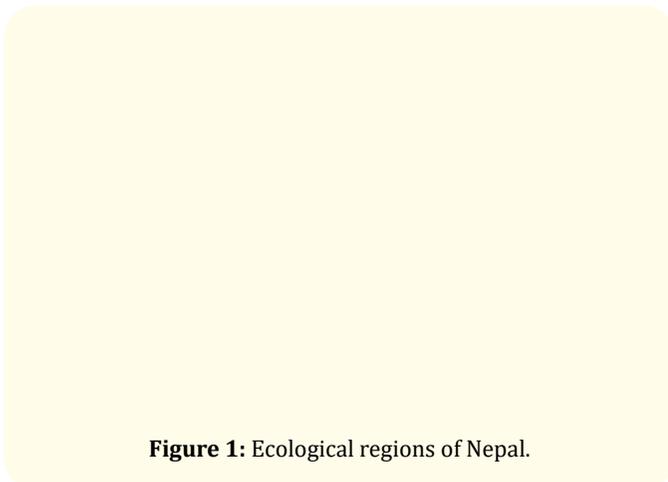


Figure 1: Ecological regions of Nepal.

Mountains

Intensive production systems do not exist for both ruminants and non-ruminants in the mountain ecology. Majority of livestock species are reared under extensive and semi-extensive management systems. In the high altitude alpine regions, transhumance grazing system is practiced in which ruminant livestock are grazed on local pastures in foothills and forest during winter (from November to late March) and spend late spring and summer months (from April to October) on high altitude pasture.

Hills

Livestock production systems in hilly regions are mainly extensive and semi-extensive with small numbers of farm animals

raised under intensive system. In the extensive system animals are freely grazed during day time either on forest land or on crop fields after harvest. In the semi-extensive system, productive animals are grazed during daytime and stall fed with supplements in the evening and morning at the homestead. The supplements include kitchen waste, maize flour mixed with rice bran and a small amount of salt - the mixture is cooked and called Kudo. Tree fodder, grasses and legumes collected from cultivated and forest lands are provided daily. Goats, after browsing during the day, are offered a modest amount of maize grains under semi-extensive system.

The intensive system of ruminant production is not common in the country. A few government farms and some private farms practice this system of ruminant production whereby the animals are stall fed with compound feed throughout the year. In addition, green forage during the flush season (May to September) and hay or silage during the dry season (October to April) is provided. The general ratio of concentrate to forage given to these livestock is 30:70 on dry matter basis.

Non-ruminants such as pigs and poultry are mostly raised under intensive system. Intensive poultry production is localized near urban and semi-urban areas, highly concentrated in Chitwan district near Kathmandu and Pokhara valleys. Large flocks of poultry (nearly 100 000 birds/farm) are raised commercially under both deep litter and cage systems (Table 5). The proportion of birds under intensive system of production is about 50 percent and now commercial poultry production trying to achieve self-sufficiency for Nepal. The exact number of pigs under intensive production system is not documented.

Rural pigs predominantly subsist on scavenging feeding system and small amounts of grains are supplemented during evening. Pigs are fed rice bran mixed with kitchen waste and small amount of maize grits. Locally available roots and tubers are also fed to pigs in rural areas [11].

Terai

Livestock rearing in the Terai region resembles to that of mid-hills and foot-hills/mountains where farmers keep livestock under both extensive and semi-extensive systems. However, intensive rearing of improved cattle, swine and poultry birds is increasingly practiced, especially in areas with better access to market. Improved cattle are raised on semi-intensive scale. They are fed seasonal fodders, wheat straw/rice straw and supplemented with a mixture of rice bran, wheat bran and maize grit.

Feed resources

Roughages

Crop residues constitute large parts of animal feeds in almost all ecological zones. Approximately 40 percent energy is supplied by crop residues. Paddy straw is the dominant roughage source. Other crop residues include wheat straw maize straw and legumes chun-

nis. In addition to stall feeding of crop residues, animals are also grazed for limited periods in the agricultural fields after harvesting of food/cash crops.

Crop residues

Crop residues either processed or unprocessed dominate the ruminant feeding in Nepal. Farmers use their indigenous knowledge to decide processing of the crop residues based on toughness

of the residue and the stage of development of the animal (whether lactating, or growing). Further, the feeding of crop residues either sole or along with other supplements is also decided by the level and stage of productivity of the animal to be fed. The most commonly used crop residues are rice straw, wheat straw, maize stover, hulls of mustard and leguminous crops (Table 3). Among these, rice straw is the most popular as it is more palatable and becomes available in October-November when there is an acute feed shortage due to extremely cold weather.

Crops	Crop and crop by-products ('000 tonnes)				
	Main product	Residues	Oil meals	Oil cakes	Bran/husk
Rice	4 505	6 757			
Maize	19 999	59 997		15 999	1 600
Millet	306	1 222			
Wheat	1 727	2 591			138
Barley	34	51			360
Buck wheat	10	15			
Oilseed	179	104	104	125	
Sugarcane	2 930	733			
Cotton	0.15	0.05	0.052	0.12	
Pulses	357	1 427		250	
Total	30 047	72 896	104	16 374	2 099

Table 3: Crop residues and by-products available in Nepal.

Source: MOAD 2013.

Wheat straw is another popular roughage source that constitutes greater part of the livestock feed in the hilly areas of Nepal where there is no or little rice grown. Like rice straw, wheat straw has poor nutritive value but when treated with urea or fed with other supplements, it helps meet the feed demand during feed scarcity periods. Hulls of soybean, mustard and other leguminous crops are usually preserved for feeding dairy animals during winter season. After separation from main crop, the hulls are further stamped/crushed to increase its palatability. Hulls are usually cooked for a while or simply soaked in water for a couple of hours before they are offered to animals. This further enhances the palatability and perhaps the digestibility as the cooking increases the solubility of structural carbohydrates.

Maize fodder is an important feed source in all three ecological zones. Thinned green maize plants at different growth stages and stovers, after cub harvest are one of the major sources of feed to ruminants, and, if surplus available, dry stalks are kept for dry period feeding. Conservation of maize fodder as silage is not commonly practiced in Nepal except by few newly emerged commercial farmers and government farms. Rice cultivation is dominant to Terai and hills [12] with no rice cultivation in the mountainous zone [13]. Rice straw is a major feed resource for ruminant animals during dry period and often supplemented with small amount of bran for feeding to dairy animals throughout the year.

Land type	Area ('000 ha)	Percentage	DM* (tonnes/ha/year)
Agriculture land - cultivated	3 091	21.0	12.0
Agriculture land - uncultivated	1 030	7.0	0.4
Forest including shrub land	5 828	39.6	1.8
Grassland including pasture	1 766	12.0	1.8
Water	383	2.6	0.0
Other	2 620	17.8	0.4
Total	14 718	100	

Table 4: Land use statistics and forage yields from different land categories in Nepal (2013).

Note: Forage cultivation 5% of total cultivated land, Source: MOAD, 2013.

Green fodder

Fodder tree leaves, leaf litter and other green resources collected from forest, grasses and legumes collected from cultivated lands are major ruminant animal feed resources in Nepal. Fodder tree leaves are fed during December to June in hilly regions of Nepal [14]. During day time cattle are fed rice straw and in the evening they are offered tree leaves. Goats are mostly fed tree leaves [15,16]. Feeding of tree leaves is less popular in Terai where plenty of grazing land and other feed resources are available and animals are mostly fed cultivated fodder from July to November.

Nepalese farmers feed their animals with locally available grasses and tree leaves to meet their daily dry matter need specially in the hills. Recently some farmers have started cultivating improved fodder varieties such as Napier, Mulato, Stylosanthes, Berseem, peas and oats. Natural/wild grasses, herbs and shrubs make large part of ruminant diets. The Government of Nepal has planned to cultivate improved fodder on 76 000 ha land by the year 2013-2014.

More than 50 species of improved leguminous perennial and annual forages were recently introduced in Nepal to increase quality feed supply. These include Stylosanthes, Butterfly pea, Glycine and Centrosema and Vetch including *Leucaena leucocephala* as fodder tree. Legumes are considered important and as substitute to costly concentrate in feeding livestock.

Livestock farming is closely integrated with forestry as about 40 percent of livestock feed is derived from forests and trees grown on farms. There are about 700 species of fodder trees distributed across the country whereas more than 30 species are grown in the community as well as private farm land in Nepal. Leguminous and non-leguminous fodder trees are widely cultivated in the country and serve as important feed source during winter.

Concentrates

Nepalese livestock are traditionally reared in low input systems hence are often not fed any concentrate unless it is absolutely required. Small amounts of home-made concentrate (kundo), maize grits mixed with rice bran, kitchen waste, and other vegetables excess of human consumption, is the common practice in rural areas for ruminant animals specially lactating cattle buffalo, sheep and goats.

Maize grain is mainly used in formulating supplement for both ruminant and non-ruminant livestock. In addition to domestic annual production of 1.95 million tonnes, the country feed industry imports 235 349 tonnes (60%) maize from India and USA to meet the nation need [10,17]. Rice and rice by-products such as polish and bran are the second most important feed supplement (Table

3). In rural areas rice bran, maize grits and kitchen waste are mixed in 60:30:10 ratio and cooked and fed as 3 kg/head to lactating animals every morning.

All the three eco-zones annually produce 1.54 million tonnes wheat [2]. Wheat grains in excess of human consumption or when heavily infested with insect pests are used for animal feeding. When maize grains get expensive and are unavailable then wheat grains are used in poultry feed [14]. Wheat bran is mostly used in dairy animal feeding; either by feed formulation or alone wheat bran fed to dairy animals in semi commercial milk producing areas.

Millets (0.29 million tonnes/year) and barley (0.03 million tonnes/year) are hills and mountain dry land crops mainly used for human consumption, very little amounts are used for animal feeding, sometimes solid millet paste (Dhido) is fed to fattening male goats, male buffaloes and oxen. Barley is only produced in high mountain areas and mostly used for human food, but occasionally fed to young sheep and goat kids and calves as feed supplements.

Often roots of perennials e.g. colocasia (*Colocasis esculenta*), yam (*Dioscorea esculenta*) and their by-products are used to prepare liquid slurps to feed pigs and poultry birds that are reared on small scale. Other roots and tubers like sweet potato, cassava, potato, radish, colocasia, turnip etc. are occasionally fed to pigs [11] and other animals in small quantities.

Oil seeds meals and cakes are only used in commercial feed or included in the ration of livestock raised under intensive systems. In rural areas of southern part of Nepal (Terai) little amount of oil-seed cakes and meals are mixed with chopped rice straw and fed to ruminant animals. Whereas ordinary system of rearing supports with liquid slurps (locally made paste) and locally made concentrates that are mostly based on by-products of cereals only. Oil seed cakes and meals are only valued for poultry ration formulation for intensive system of rearing (Annex 2).

Animal origin feed resources, fish, bone and meat meals (mostly imported) are conventionally used in intensive feeding of poultry and pigs. Most protein sources of animal origin are imported from India while small amounts of bone meal are produced in Nepal by a government-owned bone meal factory.

Commercial poultry feed

Commercial poultry production is an emerging business in Nepal which produces 130 722 tonnes of chicken and 1 765 million eggs for human consumption. The per capita availability is 4.8 kg poultry meat and 65 eggs per year. Likewise, to feed commercial livestock, 783 701 tonnes of commercial feed (92% poultry feed, 5% and 3% cattle and pig feed respectively) are produced by 120 registered feed companies in Nepal (Table 5).

Description	2012/13	2013/14
Broiler parent ('000')	1 115	1 097
Layer parent ('000')	103	137
Commercial broiler ('000')	76 062	70 686
Commercial layers ('000')	8 212	10 427
Total ('000')	85 492	82 347
Commercial production		
Chicken meat (tonnes)	132 354	130 722
Eggs ('000')	1 490 575	1 764 649
Feed (tonnes)	755 278	783 701

Table 5: Commercial poultry and feed production in Nepal.

Source: Bhattarai 2014.

Feed resources, requirements and balance

Data on feed assessment was generated based on available information of different types of feed produced for existing livestock species in the country during 2012. Feed assessment was made for the three major livestock rearing systems (extensive, semi-extensive and intensive systems) considering two types of feeds; homemade and compound feeds. Ruminant and non-ruminant populations were distributed proportionately among the four pro-

duction systems e.g. extensive, mixed extensive, crop-livestock and intensive systems.

- Those values were then multiplied by the total feed required per day per animal. The availability of different feed categories was estimated using the production data of main crops and extraction ratios (Table 3 and 4) based on local estimates and published literature [18]. The contents of DM, CP and ME in feeds were calculated using feed composition tables [18,19].
- Based on the data generated on feed supply and requirement, contributions of each feed category were determined [19].

The output-input ratio of human edible protein was calculated (Table 8a and b) for major livestock species.

In spite of its small size, Nepal has one of the highest livestock densities. Globally, Nepal ranks in 4th position among buffalo producing countries (India 1st, Pakistan 2nd and China 3rd) while numbers of other farm animal species are also high in comparison to available land resources (Table 4). Estimated annual feed supply from indigenous sources is provided in Table 6 while Table 7 displays estimates for feed requirements.

Feed Category	Quantity produced	Used as feed	DM ('000 t)	CP ('000 t)	ME ('000 MJ)
Crop residues	72 096	28 838	25 955	1 038	170 262
Forages cultivated	2	2	1	0	5
Grazing and cut and carry	15	8	2	0	20
Grain	3 005	150	135	16	1 758
Grain by-products	2 099	1 050	945	189	10 144
Oilseed cake/meal	16 478	9 887	8 898	1 780	95 566
Total	93 695	39 934	35 935	3 023	277 755

Table 6: Feed supply ('000 tonnes, ME '000 MJ) from indigenous sources in Nepal.

Animal Species	DM	CP	ME
Cattle	15 976	1 438	142
Buffalo	13 559	1 220	121
Sheep	284	26	3
Goats	21 641	1 948	193
Pigs	754	68	7
Poultry	1 594	143	14
Ducks	28	2	0
Total	53 836	4 845	479

Table 7: Feed requirements (DM and CP in '000' tonnes, ME in '000' MJ).

Production per animal is very low compared to many other countries, as one of the major factors to limit animal production is the low supply of animal feeds and forage in relation to requirements with 33, 38, and 42 percent deficit in dry matter, crude protein, and metabolizable energy, respectively.

	DM	CP	ME
Availability	35 935	3 023	277
Requirements	53 836	4 845	479
Balance	-17 901	-1 822	-202
Balance as %	-33.3	-37.6	-42.3

Table 8: Feed balance (DM and CP in '000' tonnes, ME in '000' MJ).

Nepal is a mountainous country where steep land is a consistent feature in mountain and hills, protected areas, wildlife reserves. These land together with national parks that covers over 23 percent of geographical area are not available as feed resource for domesticated animals. There is limited knowledge and practices in conservation of feeds, forages and crop residues. Most of the straw produced in farmers fields is burned. There is no implements attached in crop harvesting machines for straw collection which also leaves crop residues (rice and wheat straw) in field.

Most of green forages are available in rainy seasons and are not fully utilized through silage or hay making thus contributing to feed scarcity in dry period (December to June).

Human edible protein output-input ratios (2013)

About 105 tonnes of human edible protein is available from animal sources (meat, milk and eggs), of which around 60 percent is provided by milk from buffalo and cattle (Table 9).

Commodity	Product	Production ('000 tonnes)	Crude Protein (%)	Crude Protein ('000 tonnes)
Cattle	Milk	492.38	3.8	18.71
	Meat	NA	14.7	0
Buffalo	Milk	1,188.43	3.8	45.16
	Meat	175.13	11.3	19.79
Sheep	Milk	NA	5.9	0
	Meat	2.72	13.5	0.37
Goats	Milk	NA	3.6	0
	Meat	55.58	14.0	7.78
Pigs	Meat	18.71	12.0	2.25
Chicken	Meat	42.81	12.3	5.27
	Eggs ('000)	874.19	6g/egg	5.25
Duck	Meat	0.22	12.3	0.03
	Eggs ('000)	13.10	6g/egg	0.08
			Total	104.67

Table 9: Human edible protein output.

With regards the edible protein output input ratio, among the livestock species, goats and sheep are the most efficient (Table 10) followed by pigs and buffaloes because very few grains are being used for these animal species, whose feed mostly depends on roughages (green and crop residues) and by-products (rice bran, wheat bran and other human food waste in pig production). Edible

protein output input ratio in cattle appears very low because beef is not used for human consumption (taboo). Likewise, buffalo meat is also only eaten by few casts and buffalo meat has not fully consumed. Nepal has been importing grains like maize (60%) and soybean (over 90%) and other by-products (sunflower cakes, de-oiled cakes etc) for commercial chicken, pigs and dairy animals.

Species	Grain fed (tonne)		Protein output (tonne)				Output - input ratio
	DM	CP	Milk	Meat	Egg	Total	
Cattle	55 692	5 569	18 710	0	-	18 710	3.36
Buffalo	139 322	13 932	45 161	19 789	-	64 950	4.66
Sheep	431	43		367	-	367	8.53
Goats	6 938	694		7 781	-	7 781	11.22
Pigs	5 015	501		2 245	-	2 245	4.48
Poultry	67 773	6 777		5 266	5 245	10 511	1.55
Ducks	608	61		26	78	104	1.72

Table 10: Human edible protein output-input ratios by farm animal species.

Government policies related to investment in the livestock sector and natural resource management

The Agriculture Perspective Plan (1995-2015) of the Government of Nepal envisages several policy related issues for improving the country's GDP through increased production and supply of livestock products. Some of these are described below:

- The Rangeland Policy of Nepal promotes the sustainable use and development of natural rangeland with the objective to support livelihoods of local populations and also the development of the livestock sector through sustained feed supply and grazing management.
- The Agriculture Development Strategy (ADS), which forms part of the recently launched long-term plan of the Government of Nepal, envisages the sustainable use of available natural resources as feeds for livestock to support increased resilience and sustainable development of the livestock sector in the country.
- The Concentrate Formulation Act envisages quality control through better supply and marketing of quality feed ingredients to comply with the existing rules and regulation of the Government of Nepal.

Issues related to the animal feed act 2033 (1976)

Section 10 of this act empowers the government to set feed quality standards through notification [20]. The poultry entrepreneurs hold that the present standards are out-dated and irrelevant for present day commercial operations, and there is a need to update the standards, in active consultation with stakeholders.

The second issue vis-à-vis this law is related to implementation. The regulatory mechanism to check feed quality, although provisioned in the law, is operationally very weak and often hampered by insufficient and poorly equipped laboratories for analysis. Due to these weaknesses, imports of low quality materials from India find an easy way into Nepal against the spirit of the existing law. Addressing both these issues, which are within the legal jurisdiction of the government, requires active co-operation of the stakeholders. Unless these are effectively addressed, Nepal's benefits from WTO membership would be undermined, and indeed Nepal could stand to lose if the current situation continues.

In spite of the constraints in the formulation and enforcement of the feed laws/policies, Government of Nepal has been continuously addressing this sector by identifying and launching possible ways to maintain quality as well as producing sufficient quantity of feed for both ruminants and non-ruminants. The growing interest of the private sector in establishing feed industries is an example of positive initiatives in this sector. Recently, Government of Nepal also has emphasized in its policy to support private industries by facilitating custom duties and relaxing rules and tariff regulations for purchasing important ingredients from abroad.

Agriculture development strategy (ADS, 2013)

Nepal desires to follow the food consumption trends of other Asian countries. Wheat products will replace rice in the human diet. The shift in food habits from rice to wheat or maize is projected to pose a serious competitive threat on animal feed. This is exacerbated by the increased demand for milk and meat requiring more animals to be raised within the country. There is considerable potential to increase maize production through use of improved high yielding varieties. The current import of maize and oilseed cake is showing trends that should have been restricted while encouraging indigenous production of these crops.

The agriculture development strategy (ADS) envisages that the regulatory capacity would encompass the whole food chain, extending from rigorous assessment and registration of agricultural inputs (such as pesticides, veterinary medicines and biotechnology products) and livestock feeds to food processing additives.

There is significant potential to use Nepal's comparative advantage through further developing irrigation systems and improving their operation. Irrigation remains a policy and investment priority. From the economic perspective, investment is required, but it must be for feasible and well-managed irrigation based on adequate economic rate of return from high value crops, multiple field crop systems, including feeds and fodder for dairy and poultry.

The Nepal Agricultural Research Council (NARC) has prioritized proper management of fodder and feed for sustainable livestock development under Theme 2 of the NARC Vision 2011-2030, that includes:

- Development of year-round fodder production systems for reducing the production cost of dairy;
- Rangeland resource management through exploration of indigenous and scientific knowledge;
- Improvement of locally available non-conventional feed resources;
- Improving productivity of fish through developing appropriate feeds and feeding management;
- Nutrient fortification in mechanically compressed feed blocks; and
- Promotion of integrated crop, forest, livestock and fisheries development.

Youth self-employment scheme

Government of Nepal is encouraging its people to create employment through self-efforts. Within the natural resource sector, livestock is an important sector for employment generation. Under the Youth Self-employment Scheme, Government of Nepal has allocated special funds to support creating jobs/employment for youth in the livestock sector. Issues related to feeds and feeding manage-

ment are becoming a matter of great concern to the farmers and entrepreneurs.

Regulation of feed trade

Tariffs on feed imports

Recently, Government of Nepal has emphasized in its policy to support private industries by facilitating custom duties and relaxing rules and tariff regulations for purchasing important ingredients from abroad. Agricultural reform duty is levied at a flat rate of 10 percent *ad valorem* on those agricultural products that face no customs duty. Thus, even those imports eligible for duty free import from India and Tibet are subject to a levy. The purpose of this duty is to provide some protection to domestic products while remaining within the broad framework of the Nepal-India bilateral treaty, which provides for trade in primary products free from customs duty and quantitative restrictions. A local development *duty* is also levied on imported items at the rate of 1.5 percent *ad valorem* [21]. In the case of feed, it is somewhat complex to determine the level of tariff protection.

Nepal has committed to amend existing relevant laws rules and regulations to make them WTO compatible [22]. Of direct concern to the poultry industry are the laws concerning export and import and customs valuation listed in the legislative action plan of Nepal's submission to the WTO, which include feed. Nepal has also introduced a law on anti-dumping by July 2004. Parallel to these developments, the government is also reviewing the current Food Act 2023 (1966) with an intention to update it to meet the future feed requirements [21]. The updated Act will soon be available for public scrutiny.

Phyto-sanitary regulations

The Government of Nepal is intent on implementing rules and regulations covering phyto-and zoo-sanitary safeguards for international trade in plants and animals and products derived therefrom. Quarantines are maintained at all check points bordering India whereas airport quarantines are maintained for international cargo and related stock imports via air routes. Phyto-sanitary regulations are felt important in controlling diseases, parasites, and related vectors that could have untoward effect on existing crops, trees, livestock and the associated sectors in the country. Importation of plants, feedstuffs, and animals have to follow safety guidelines and comply with national and international regulations to prevent the entry of possible vectors and/or disease agents.

Restrictions on exports

There are no export duties on any of the poultry products. Two feed ingredients, namely rice bran and molasses, are however subject to export duty at the specific rate of Rs. 0.25 per kg [21]. This is subjected to change in terms of price adjustment. Nepal is already

short of feed to support its growing livestock population. Therefore government's policy is to move towards self-sufficiency in feed production and support its livestock's requirement, which necessitates to restrict export of feed ingredients [23-57].

Conclusion and Recommendation

Nepal, situated in between two large countries (India and China), comprises 147 thousand hectares of land in three major ecological regions (mountains, hills and Terai) and is densely populated with livestock per unit of available land resources, which is one of the factors limiting farm animal production. At present there Nepal has a 33.4, 42.8 and 42.4 percent feed deficit in terms of dry matter, protein and metabolizable energy, respectively.

The following conclusions are drawn from this study

- Nepalese farming systems are typically integrated crop-livestock in nature where the role of livestock is pivotal in supporting the livelihood of Nepalese people. All types of livestock species including ruminants, non-ruminants are reared across the ecological domains where feeding management is often traditional in nature and varies.
- Forest, fodder trees, crop lands, crop residues, stovers and by-products are major feed resources in Nepal and their supply is seasonal. Livestock feed situation is not constant in terms of seasons as well as ecological belts. Dry season (December to May) is the hard hit season with scarcity of feeds whereas feeds and feed by-products are abundantly available during summer. Conservation of fodder to overcome and manage feed shortage periods is minimal.
- Tree fodder plays pivotal roles in feed management during winter and more than 100 fodder tree species are domesticated in the country. Growing leguminous and non-leguminous fodder trees is a common practice by local farmers.
- Large numbers of improved fodder species including perennial legumes were introduced in the country that have increased feed supply for livestock. Current government policy aims to sustainably manage feeds utilization and resource use through proper management.
- Government of Nepal has implemented several policies to regulate production and quality aspects of feeds and feeding management that would, hopefully, support in mitigating feed requirements of increasing livestock population in the country.

Nepalese livestock population census only started 2001 and the national statistics do not report data on crop residues [1]. Establishment of research institutions was also started lately in 1991. Only grain yield has been listed in research publications and quantitative information on crop residues and by-products is scarce. Due to diverse geographic regions precise estimation of feeding

resources and other data collection is very difficult. Nutrient content databases of feed resources are in the development stage and feed formulation is mostly based on feed composition and requirement standards published by other countries [19]. Information on anti-nutritional compounds present in local feeds, especially in plants in relation to stage of growth is also lacking.

The marketing potential of the livestock sector is ever increasing in Nepal. Most of the livestock products are consumed domestically. The country demand for milk and meat is not met from the current domestic production. Marketing potential is thus related with industry development that is well linked to the pricing, quality as well as quantity supply of animal feed ingredients.

Livestock production is commercializing in peri-urban as well as urban areas, thus there is a need to develop required facilities that could promote commercialization of livestock production.

Feed is one of the major constraints to promote livestock development. There should therefore be a good programme and plan to facilitate all the year round forage production and improvement of low quality feed resources in the country so that per unit production costs would be lowered and profit margin would be reasonable to the farmers/entrepreneurs.

Quality control measures should be regulated through appropriate control mechanism to produce quality feed, milk and milk products, meat, eggs and other livestock products.

A detailed study on concrete status of feeds and feeding situation should be initiated considering niche specific variation in the country. Generated panel data in long run would thus provide firm basis and standard statistics to help develop livestock sector in relation to feeds and feeding management.

Bibliography

1. MOAD. Statistical Information on Nepalese Agriculture. Ministry of Agricultural Development. Agri-business Promotion and Statistics Division. Agri-Statistics Section. Singhdurbar, Kathmandu, Nepal (2013).
2. Devkota NR., *et al.* "Identification of suitable forage grasses and legumes for supplying fodder throughout the year at IAAS Livestock Farm". In: F. P. Neupane (ed.). IAAS Research Reports (1985-1991), Institute of Agriculture and Animal Science, Nepal (1991): 467-480.
3. ASD. Statistical information on Nepalese Agriculture. Agricultural Statistics Division, Singh Durbar, Kathmandu, Nepal (1998): 102.
4. Sherchand L. "Herd composition of cattle, buffalo, sheep and goat in Nepal". Proceedings of the 4th National Animal Science Convention, Kathmandu, Nepal (2001).
5. Singh SB. "Indigenous buffalo bull management system in Nepal: case studies of Tanahu and Makawanpur districts". Proceedings of the 5th National Animal Science Convention, Kathmandu, Nepal. October 15-16, 2003. Nepal Animal Science Association, Nepal (2004): 231-236.
6. APP. Agriculture Perspective Plan. Agriculture Projects Services Centre Kathmandu, and John Mellor Associates, Inc. Washington, DC (1995).
7. TLDP. "Forage seed production area mapping". Third Livestock Development Project, Hariharbhawan, Lalitpur (2002): 1-20.
8. Pariyar D. "Existing Feed Situation in Different Regions of Nepal and Strategies Developed to Increase Fodder Production". ISGR, Huhehot, Inner Mongolia, PR China (1993).
9. Pandey RS. "Fodder and Pasture Development in Nepal". Udaya Research and Development Services (P.) Ltd. Kathmandu, Nepal (1997): 159.
10. Bhattarai TC. "Present situation of commercial feed production and its prospect in Nepal". Paper presented in National Workshop on Animal Nutrition. Organized by Department of Livestock Service, Ministry of Agriculture Development Nepal in July 14 (2014).
11. Osti NP and P Mandal. "Roots and rubbers: Alternate energy rich feed ingredients for rural pig production". Hydro Nepal Journal-Special Issue on Proceeding of National Conference on water, food security and climate change in Nepal (Peer reviewed) (2012): 42-43.
12. Khatiwada SP and HK Manadhar. Crop research in Nepal: Present status and future strategies. Proceedings of the SAS-N Convention April 4-6, 2012. Society of Agricultural Scientist Nepal (SAS-N) Kathmandu, Nepal (2013):1-13.
13. MOAD. "Statistical Information on Nepalese Agriculture". Ministry of Agricultural Development. Agri-business Promotion and Statistics Division. Agri-Statistics Section. Singhdurbar, Kathmandu, Nepal (2012).
14. Osti NP, *et al.* "Replacement of maize by wheat with supplemental methionine and lysine for broiler production in low protein diets". Paper presented at 2nd SAS Convention held in July 30 – August 1, 2003, Khumaltar, Lalitpur, Nepal (2003).
15. Pandey LN., *et al.* "Indigenous knowledge of fodder tree selectivity by goats in the mid-hills of Nepal". *Journal of Enterprising communities: People and places in the Global Economy* 3.3 (2009): 241-255.
16. Degen AA., *et al.* "Invitro gass production from fodder tree and shrubs from mid hills of Nepal using cow, sheep and goat rumen liquor". *Journal of Agricultural Science* 148 (2010): 1-7.

17. Paudyal KR and NP Osti. "Maize in transition from food to feed crop: Policy implications and sustainability issues". Paper presented at 2nd SAS Convention held in July 30 – August 1, 2003, Khumaltar, Lalitpur, Nepal (2003).
18. Animal Nutrition Division (AND). Annual Report 2012/13. Animal Nutrition Division, National Animal Science Research Institute (NARSI), Khumaltar Lalitpur Nepal (2013).
19. National Research Council (NRC). "Nutrient requirement of Poultry 9th revised edition". National Academic Press Washington DC USA (1994).
20. LBMB. Feed Act, 2033, in Nepal Law Compendium (Ka) (in Nepali), Kathmandu: Law Books Management Board, Ministry of Law and Justice, His Majesty's Government of Nepal 7 (1999).
21. Chapagain DP. "Commodity case study: Poultry products". (2004).
22. WTO. Report of the working party on the Accession of the Kingdom of Nepal, accessed through the WTO (2003).
23. ADS 7762-NEP. Draft Final Report. "Technical Assistance for the Preparation of the Agricultural Development Strategy". Asian Development Bank (2013).
24. Agriculture Atlas of Nepal. Agribusiness Promotion and Statistics Division, Ministry of Agriculture Cooperatives, Government of Nepal Singhadarbar Kathamndu Nepal (2012).
25. Bhattarai TC. Poultry enterprise in Nepal- Past to present: on the edge of challenges. In: Poultry Sanchar: A monthly journal for the promotion of Nepalese poultry industries 1 (2012): 2.
26. Bhattarai N. Morphological characterization and productive performance of local Terai goat in Sirsha district, Nepal. M.Sc. Thesis (unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2007): 92.
27. Chapagain PB. Comparative performance of meat type rabbits in Western hills of Nepal. M.Sc. Thesis (Unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2012): 100.
28. Degen AA., *et al.* "Goat production and fodder leaves offered by local villagers in the mid hills of Nepal". *Journal of Human Ecology* 38.5 (2010): 625-637.
29. Kharel M., *et al.* The Nepali Yak. Himalayan College of Agricultural Sciences and Technology (HICAST), Gatthaghar, Bhaktapur, Nepal (2010).
30. Kolachhapati MR. "Phenological study of hill goats under different management systems and nutritional regimes". Ph.D. Thesis (2006): 148.
31. Kolachhapati MR and NR Devkota. Entrepreneurial goat production in the eastern mid-hills and Terai region of Nepal. Technical Publication. National Agricultural Research and Development Fund (NARDF). NARC Building, Singh Durbar Plaza, Kathmandu (2012).
32. Maharjan BL. "Prospects of Feed Crops in Nepal: the Role of CGPRT Crops". United Nations. CGPRT Centre working paper 65 (2003).
33. NARC. "NARC's strategic vision for agricultural research 2011-2030". Meeting Nepal's food and nutrition security goals through agricultural science and technology. *Nepal Agriculture Research Council* (2010).
34. Neopane SP and PK Pokharel. "Indigenous cattle of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2005).
35. Neopane SP and PK Pokharel. "Indigenous goats of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2008).
36. Neopane SP and PK Pokharel. "Indigenous cattle of Nepal (in Nepali language)". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2012).
37. Neopane SP and R Kandel. "Indigenous pigs of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2008).
38. Neopane SP NA., *et al.* "Indigenous chicken of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2008a).
39. Neopane SP., *et al.* "Indigenous sheep of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2008b).
40. Neopane SP., *et al.* "Indigenous buffalo of Nepal". Animal Breeding Division, NASRI/NARC, Khumaltar, Lalitpur, Nepal (2007).
41. Nepal Hatchery Industries Association. Parent Import Record. Tribhuvan International Airport Quarantine, Kathmandu, Nepal (2013).
42. Pandeyl KR. "Estimation of genetic parameters of production traits of pigs". M.Sc. Thesis (unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2010): 106.
43. Pandey SR. Performance of Khari goat and its crosses in the hills of Tanahu district, Nepal. M.Sc. Thesis. TU/IAAS, Nepal (2007): 84.
44. Pandey SR. Performance of Khari goat and its crosses in the hills of Tanahu district, Nepal. M.Sc. Thesis (unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2007).

45. Parajuli AK. Morphometric characterization and performance evaluation of hill goat in mid hills of Nawalparasi district of Nepal. M.Sc. Thesis (Unpublished). TU/IAAS, Rampur, Chitwan, Nepal. (2012): 118.
46. Pariyar D. "Fodder Oats in Nepal". Pasture and Fodder Division, Khumaltar, Nepal (2005).
47. Pariyar D. "Existing feed situation in different regions of Nepal and strategies developed to increase fodder production". ISGR (1993).
48. Paudyal SP. Best practices in animal feed production and management in Nepal (2003/04).
49. Sapkota S. "Comparative performance of goat representing eastern western and central regions of Nepal". M.Sc. Thesis. Department of Animal Breeding and Biotechnolgy, TU/IAAS, Nepal (2007): 138.
50. Sharma MP. "Species and breed of poultry interaction with management systems and their performance". PhD Dissertation. TU/IAAS, Rampur, Chitwan, Nepal (2006).
51. Shrestha KK. "Agroecosystem of the Mid-Hills. In: Sustainable livestock production in the mountain agro-ecosystem of Nepal". FAO Animal Production and Health Paper (1992).
52. Thapa DB. "Phenogenetic study on litter and reproductive traits of exotic swine breeds under farmers' managed condition". M.Sc. Thesis (unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2010).
53. Thapa S. "Estimation of genetic and non-genetic parameters of Murrah buffalo in Livestock Development Farm, Pokhara, Nepal". M.Sc. Thesis (unpublished). TU/IAAS, Rampur, Chitwan, Nepal (2012): 86.
54. Tiwari MR., *et al.* "Nutritional Variation of Different Feed Ingredients and Compound Feed Found in Different Parts of Nepal". *Nepal Agriculture Research Journal* 7 (2006): 75-81.
55. Upreti CR. "Livestock, poultry and fish nutrition in Nepal". (2008).
56. Upreti CR and BK Shrestha. "Nutrient Contents of Feeds and Fodder in Nepal". Animal Nutrition Division. NARC, Khumaltar, Lalitpur, Nepal (2006).
57. Yadav JL and NR Devkota. "Feeds and feeding situation of livestock in the Terai region of Nepal". FAO, Kathmandu, Nepal (2004).

Volume 4 Issue 1 January 2020

© All rights are reserved by Netra P Osti.