Assessment of Feed Resources, Feeding Practices, Nutritional Status, and Future Strategies for Improving Productive and Reproductive Efficiency of Dairy Animals including Standard Operation Procedure (SoP of Nepal

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Submitted to

National Livestock Sector Innovation Project (NLSIP: P156797)

Ministry of Agriculture and Livestock Development

Project Management Unit,

Hariharbhavan, Lalitpur

Nepal

July, 2019

ACRONYMS AND ABBREVIATIONS

AU	Animal Unit
CFUG	Community Forest User Group
CP	Crud Protein
BPP	Bypass Protein
DE	Digestible Energy
DLS	Department of Livestock Services
DLSU	Decentralize Livestock Support Unit
DM	Dry Matter
DTMRB	**Densified** Total Mixed Ration Block
FAO	Food and Agriculture Organization of the United Nations
GM	Green matter
HH	Household
LRMP	Land Resource Mapping Project
LSS	Livestock Service Section under the Municipality
LU	Livestock Unit
LULC	Land Use and Land Cover
MoALD	Ministry of Agriculture and Livestock Development
MoLD	Ministry of Livestock Development
MT	Metric Ton
MM	Mineral Mixture
NAFLQML	National Animal Feed and Livestock Quality Management Laboratory
NARC	Nepal Agricultural Research Council
NRC, USA	National Research Counci, USA
RBP	Ration Balancing Program
TDN	Total Digestible Nutrients
TMR	Total Mixed Ration
UMB	Urea Molasses Block

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Executive Summary

Livestock is an integral part of agricultural production system in Nepal, and major source of animal protein of Nepalese diet derived from milk, meat and their products Thus, rearing of large and small ruminant animals in an economical and environmental sustainable manner becomes a crucial way for sustainable livestock development in Nepal.
mountain people.

There are total 6,430,396 cattle, 5,61,950 bufflo, 11225,131 goat, and 612,884 sheep directly depending on the forage (MOALD, 2017). Most of these animal are local and only 3.4 % cattle and 4.3 % buffalo are improved, and their population is gradually increasing. The large ruminant annually produces 1,911,239 MT of milk which is 65% is from buffalo. Further, buffalo is annually producing 180,080 MT of meat in the country. The population of small ruminants (sheep and goats) is 11.9 million, of which goat population comprise 95 percent and remaining is sheep. There are only 2.7 percent goats and 0.5 percent sheep are improved and remaining are local across the country.

There are non ruminant animal sharing the feed resources, mainly the concentrate feed, in the country. They are pigs, poultry and equines (horse/mules/asses/donkeys). There are 0.87 million pigs with 7.3% improved that produces 24,535 MT meat annually , Another animal species to share the feed resources (concentrate feed) is chicken and their population is 68.6 million (about 18 % are laying) with 392 thousand (47% laying) (MOALD, 2017). Commercial poultry is rapidly growing and recorded population is of 14.5 million in the country. The poultry commodities, including laying hens, produce 57,509 MT of meat of which the share of chicken is 96 percent, and 1,352 million eggs annually

Ruminant and equines are mostly depend of fodder on private and community land, and non ruminant animal depends on concentrate feed of which more than 95 percent ingredients are imported. But the animal in Nepal are under fed with 36 percent feed deficient, mainly during winter in the country. In the context of available Total Digestible Nutrient TDN) 29 percent is deficient (NAFLQML, 2019). The shortage of feed during 1980 in terms of TDN was about 36 percent (Rajbhandari and Sah, 1980). This has indicated the positive impact on feed and fodder improvement program of the government over the past decade. The “Forage Mission: Program, as implanted by the government, has contributed to improve on the feed and feeding situation in the country (year 2012 to 2018). The program was implemented in phase wise with the targets to (a) bring additional 45,000 ha land under forage production (b) bring additional 150 ha of land under oat and 30 ha under Berseem cultivation and (c) reduce feed deficit from 8.3 million MT to 7.1 million MT. This assessemen6 also consdere the review made by NAFLQML, 2019.

The assessement of fodder production has indicated the potential to improve the fodder production in the country There have been a significant changes (build up area (65.5%) in land use pattern in Nepal over 2 decades (1990 to 2010) (ICIMOD).

As per the regular and special program of the government, the activities of production and distribution of forage seeds, and seedlings/slips of improved forage species have been implemented. APP has prioritized to reduce on the cost of animal products to create access to the consumer that needs to produce more feed and promote efficient use. Furthe, The NSIP needs to focus on the production of green fodeede, mineral mixture, DTMR and bypass proteins production in the country considering the project area.

Intending to develop the livestock commodities in Nepal, the Government of Nepal received the fund from the World Bank. in 28 February 2018 to be continued till 30th June 2023for the implementation of Nepal Livestock Sector Innovation Project (NLSIP)

The Development Objectives (PDO) of the project are to (1) increase productivity, (2) enhance value addition, and (3) improve climate resilience of smallholder farms and agro-enterprises in selected livestock value-chains in Nepal. The Project has four components: (a) Strengthening Critical Regulatory and Institutional Capacity; (b) Promoting Sector Innovation and Modernizing Service Delivery; (c) Promoting Inclusive Value Chains for Selected Livestock Commodities; and (d) Project Management and Knowledge Generation. The project is being implemented across the Mountains, Hills and the Terai in four clusters along the road corridor encompassing five newly established States. There are total 28 districts in 5 states covered by the project and the details of project districts are;

Despite the shortage of feeds and fodder resources in the country, there is an immense potential for improving productive and reproductive efficiency of animals. It is well documented that there is an immense potential for improving feed conversion efficiency (FCE) of animals in tropical countries, includingNepal. One of the best strategies for improving FCE is to feed the *Balanced Ration* as per the nutrient requirement of animals. Feeding balanced rations with judicious utilization of available feed resources, along with strategic supplementation of minerals, helps improving net daily income of dairy farmers by way of increasing daily milk yield and lactation yield, with concomitant reduction in age at first calving and inter calving interval. Balanced feeding also helps reducing enteric methane emission and manure nitrous oxide; thereby, reducing carbon footprint of milk.

In present report, we have made efforts to describe various nutritional interventions that can be implemented in project districts for achieving the targeted PDO under the NLSIP. These nutritional interventions include:

1. Ration balancing program
2. Production and distribution of mineral mixture
3. Supplementation of urea molasses mineral block in the ration
4. Chaffing of fodder
5. Enrichment and densification of crop residues
6. Compound cattle feed quality regulation
7. Green fodder production and enhancement
8. Calf rearing program
9. Greenhouse gases emission reduction
10. Use of bypass protein feed for enhancing milk production
11. Development of a broad spectrum toxin binder.

Above interventions will be implemented phase-wise, with the help of stake holders at village, districtand state level implementing agencies. This assiisement report consider the the technical specification to establish the mineral mixture plant, By pass protein production plant, DTMR plant in specific location within the NLSIP preject districts.

SECTION ONE

Assessment of Feed Resources, Feeding Practices, and Nutritional Status

Chapter 1

Assessment of Feed Resources, Feeding Practices, Nutritional Status

1. Introduction

Livestock is an integral part of farming system in Nepal. Its contribution to national economy is about 13 percent. The value of livestock for food security and youth employment is gradually increasing. The major livestock speciesto contribute to the national economyare large ruminant (cattle and buffalo) and small ruminants (sheep and goats). Small number of yak and chauri in the mountain region, about 0.4 % of total large ruminants,are the source of livelihood of the people in mountains.

There are total 6,430,396 cattle, 5, 61,950 buffalo, 11225,131 goat, and 612,884 sheep, directly dependant on the forages (MOALD, 2017). Most of these animal are local and only 3.4 % of the cattle and 4.3 % of the buffaloes are of improved breeds, and their population is gradually increasing. The large ruminantsannually produce 1,911,239 MT of milk which is 65% from buffaloes. Further, buffaloesarealso producing 180,080 MT of meatannually. The population of small ruminants (sheep and goats) is 11.9 million, of which goat population comprises 95 percent and remaining is sheep. There are only 2.7 percent of the goats and only 0.5 percent of the sheepof improved breeds.The remaining are local across the country.

There are non-ruminant animals also, sharing the available feed resources, and mainly the concentrate feeds. These are pigs, poultry and equines (horse/mules/asses/donkeys). There are 0.87 million pigs out of which only 7.3% of the improved breeds, that produce 24,535 MT meat annually. Another animal species to share the feed resources (concentrate feeds) is chicken,their population is 68.6 million, out of which about 392 thousand (18 %)are layers (MOALD, 2017). Commercial poultry is rapidly growing and recorded population is 14.5 million in the country. Thepoultry commodities, including laying hens, producing 57,509 MT of meat, of which the share of chickenis 96 percent, and 1,352 million eggs annually

Ruminants and equines are mostly dependent on fodder from private and community lands.Non-ruminant animals depend on concentrate feeds, of which more than 95 percent are imported. The animals in Nepal are under fed as there is 36 percent deficiency of feed, mainly during the winter season. In the context of available Total Digestible Nutrient TDN), about 29percent isdeficient (NAFLQML, 2019).The shortage of feed during 1980s in terms of TDN was about 36 percent (Rajbhandari and Sah, 1980). This has indicated the positive impact on feed and fodder improvement program of the government over the past decade. The Forage MissionProgram, undertaken by the government, has contributed to the improvement of feed and fodder situation in the country, especially from the years2012 to 2018. The program was implemented in the phasedmanner with the targets to (a) bring additional 45,000 ha land under forage production (b) bring additional 150 ha of land under oats and 30 ha under berseemcultivation and (c) reduce feed deficit from 8.3 million MT to 7.1 million MT. Now the impact of the mission has been assessed and the resultsare positive, with regard reduction in feed deficit, especially during winter.

There is potential to improve the fodder production in the country. There have been a significant change in land use pattern in Nepal for two decades from 1990 to 2010 (ICIMOD). The significant changes can be observed in terms of increased build up area (65.5%) and reduction in barren land (52.5), over the years.

As per regular and special program of the government, the activities of production and distribution of forage seeds, and seedlings/slips of improved forage species have been implemented. APP has prioritized to reduce the cost of animal products to create access to the consumer that needs to produce more feed and promote its efficient utilization.

Intending to develop the livestock commodities in Nepal, the Government of Nepal received the fundsfrom the World Bank on28thFebruary 2018,the program to be continued up to30th June 2023, for the implementation of Nepal Livestock Sector Innovation Project (NLSIP)

The Development Objectives (PDO) of the project are to (1) increase productivity, (2) enhance value addition, and (3) improve climate resilience of smallholder farms and agro-enterprises in selected livestock value-chains in Nepal. The Project has four components: (a) Strengthening Critical Regulatory and Institutional Capacity; (b) Promoting Sector Innovation and Modernizing Service Delivery; (c) Promoting Inclusive Value Chains for Selected Livestock Commodities; and (d) Project Management and Knowledge Generation. The project is being implemented across the Mountains, Hills and the Terai regions in four clusters along the road corridor encompassing five newly established States. There are total 28 districts in 5 states covered by the project and the details of project districts are;

(1) State 1: Panchthar, Ilam, Jhapa, Dhankutta, Morang, Sunsary, Udayapur =7 districts
(2) State 2: Saptari, Siraha, Dhanusa = 3 districts
(3) State 3: Kavrepalanchok, Kathmandu, Makwanpur, Chitwan: 4 districts
(4) State 4: Nawalpur, Tanahun, Kashki, Shyanja, Myagdi, Manag, Mustang = 7 districts
(5) State 5: Nawalparasi, Rupandahi, Kapilvastu, Palpa, Argakhanchi, Gulmi, Bardiya = 7districts.

These selected districts represent all agro-ecological zones of the country, and the program is carefully made to achieve the expected output. The districts are in feed deficits that needs support to build forage based balanced feeding system.

Some studies on the fodder seeds and sapling viability have been done but these are general in nature, not specific to the NLSIP project districts. Therefore,this work is aimed to assess the feed and feeding situation in Nepal focussing,focussing on NLSIP districts

2. Objectives to the study

The overall objective of the study is to review and assess the existing feed and feeding situation, related plan and policies, analyze the gaps of feed availability and demand for the ruminant animals, assess the available feed resources in the project districts, prepare and recommend the plan of action to promote the feed for ruminant animals with the following specific objectives;

The specific objectives with regard to assessment of Animal Feed and Feeding conditions are to;

1. review the existing feed and feeding system related to plan and policies
2. nalyze the gaps between the feed availability and demand for the ruminant animals, to further support the forthcoming Livestock Master Plan.
3. assess the available feed resources in the project districts
4. prepare and recommend the plan of action to promote the feed for large ruminants, goats including Chyangra and sheep, through value addition to theavailablefeed resources and the ration balancing program.

3. Rational of the study

Due to limited availability of feed resourcesand largely non-scientific feeding practices, animals produce far less milk, meat and fiber than their genetic potential. Various strategies would be suggested on these lines to improve milk production and reproduction efficiency, while optimizing cost of feeding. These include development and implementation of ration balancing program, production and distribution of urea molasses mineral blocks by “cold process” especially for animals fed on crop residues based diets. This would help saving expensive concentrate feeds and improve milk production. Dry fodder could be recommended for chaffing before feeding to minimizefeed wastage and improve its utilization. Dry fodder in the surplus areas would be enriched and densified in the form of blocks/bales and transposed from surplus to deficit areas. Green fodder production enhancement would be recommended by using truthfully labeled/certified fodder seeds. Surplus green fodder would be conserved in form of hay and silage for use during the deficit period. Fodder production enhancement would also be suggested by following package of practices in case of fodder trees, pastures and grazing land. Alternate feed resources would be recommended for propagation.

Since, legislation to monitor the production and distribution of compound cattle feed was drafted way back in 1976, it needs to be thoroughly revised. It should cover compound feed for all categories of animals, recommend latest parameters and test methods of analysis. Quality control labs for quality monitoring would need to be equipped. Bypass protein technology would be recommended for production of bypass protein supplement for use in feed or directly supplementing the ration of graded and crossbred animals. This will help improving milk productionwith the same quantity of protein meals. This aspect is very important as majority of the protein meals are imported and are the most expensive component of the ration.

Another important component is production and distribution of mineral mixture to the livestock species, particularly dairy animals. This would help improving the milk production and reproduction efficiency. Since age at first calving in the field animals is 4-5 years and inter-calving interval is more than 18 months, calf rearing program would be recommended, wherein, pregnant animals in the advanced stage of pregnancy would be recommended special ration and the healthy calves thus born will be fed calf starter and calf growth meal. This would have great impact on the productivity of large ruminants.

The Nepal Livestock Sector Innovation Project (NLSIP) aim at assessing the animal feed and feeding resources for the preparation of future plan for the project districts thatwould ultimately be used across the country.

4. **Approach and Methodologies**

The assignment was done with the following activities such as (1) desk review of the available information on available feed resources, feed requirement to the ruminant animal, gap analysis (2) analyzing the existing situation on the availability of feed resources and constrain in the line of fodder promotion and utilization, and (3) recommendation of plan for forage development, production, conservation and utilization for the project districts. While preparing the innovation and developmentplan, wide consultation with stakeholders was made, which is as of follows:

1. NLSIP, Project Management Team (PMT) at PMU.
2. Department of Livestock Service (DLS) (DG, DDGs and Division Chiefs).
3. National Animal Nutrition and Livestock Quality Management Laboratory Kathmandu, (Chief and support officers).
4. Animal Nutrition Division/NARC, Khumaltar (Scientists).
5. Provincial Ministry of Land Management, Agriculture, and Cooperatives (representatives).
6. Provincial Directorate of Livestock services.
7. Experts of Animal Nutrition and Breeding of NASIP, PMU, Hariharbhavan.
8. Officials from NepalFeed industry Association (NFIA), Kathmandu (Nutritionists).
9. Stakeholders/ entrepreneurs/ farmers in the selected project districts, including the agro-vets

looking after the forage seed marketing.

Further, (1) field survey in the project districts (Kavre, Ilam, Sunsari, Siraha, Rupandehi, Syngja and Kashi) was done to collect the basic feed and feeding related information, and (2) Interaction workshops at DLSU level, using District Level Dialog Platform, such as at (a) Biratnagar (b) Hetaunda (c) Butwal and (d)Pokhra, to validate the output of the assessment, two meeting were organized at central level such as (a) DLS meeting with DG and other higher officials under the DLS and (b) Ministry level meeting under the chairmanship of Secretary, MOALD, The discussion was lively and inputs were provided by the participants. The inputs and suggestionsat (a) DLSU level (b) Department level and (c) Ministry level have been well considered and included in theFinal Report.

Organization of Report

The team had been entrusted to undertake two separate studies in one go; (1) In phase 1^{st} Feed and feeding assessment (2) Phase 2^{nd} develop SoPs and Guidelines based on the findings of Phase I of the report. The report comprises (a) Assessment of the available feed resources in the project districts and (b) preparationof the plan of action to promote the utilization and availability of feeds for large ruminants, goats including Chyangra and sheep, through value addition to the available feed resources and the ration balancing program. This report document contains mainly the following chapters:

(a) Feed and feeding assessment
(b) Establishment of Mineral Mixture and Bypass protein plants
(c) Promotion of conservation of green fodder in the form of silage
(d) Fodder seed and sapling promotional program and
(e) Implementation of Ration Balancing Program in the project districts.

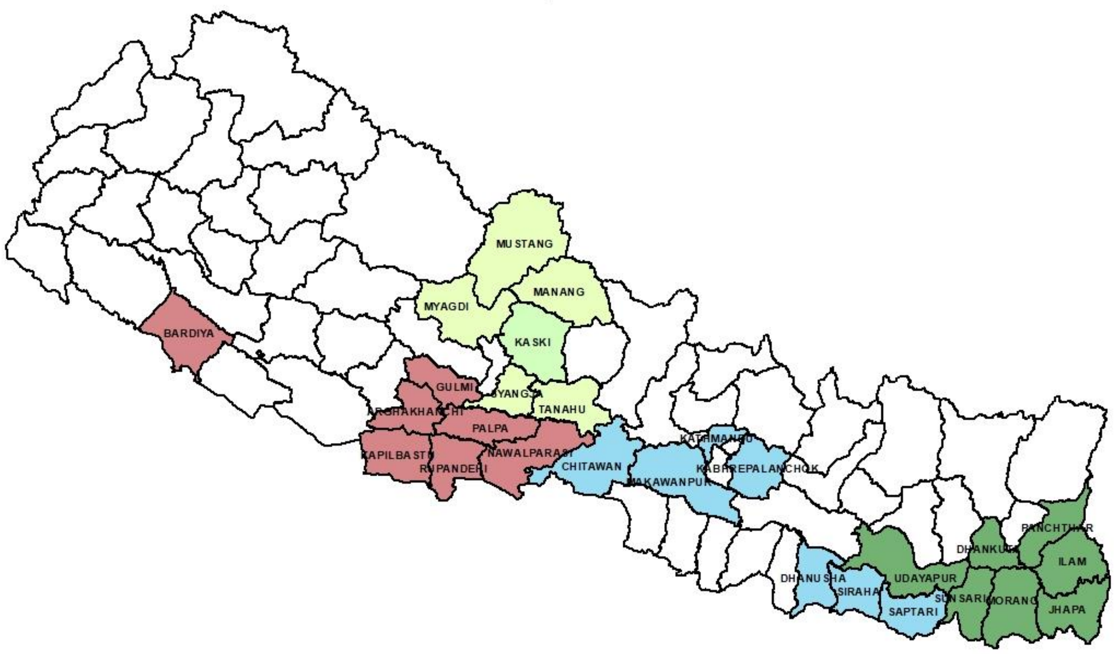

Figure 1 The Map of Nepal sowing the NLSIP project districts

Chapter 2

Feed Resources and Feeding Practices

Livestock ration primarily comprises dry fodder, cultivated green fodder, tree leaves, pastures and grazing land, depending upon the availability. In addition, conventional concentrates/compound cattle feed is supplemented in the ration, especially of milch animals. More than 95% of the total concentrates used for livestock feeding are imported and are the most expensive component of the ration, especially protein meals/cakes. Feeds and fodders are not fed in right proportion, as a result cost of production is higher, productivity is low and net profit to the livestock keepers is low.

2.1 Land use for feed resources production

The land use pattern in Nepal shows that there is about 1.7 million hectare of grass land, 3.09 million ha agricultural lands, 4.3 million has forest and 1.6 million ha shrubs land and degraded land. Of the total agricultural land, about 25 percent (i.e.1 million ha) uncultivated (Table 1).

Table 1.1: Changes in Land Use Pattern in Nepal

Land category	1990	2000	2010	Change over 1990
	Area, ha			
Forest	6,668,336	6,148,401	6,202,809	-7.0%
Shrub land	328,142	346,930	342,986	4.5%
Grassland	1,728,561	1,379,485	1,264,552	-26.8%
Agriculture area	3,753,933	4,096,968	4,039,820	7.6%
Barren area	1,006,831	1,702,002	1,535,851	52.5%
Water body	81,052	73,051	72,685	-10.3%
Snow/glacier	1,168,741	974,176	1,255,347	7.4%
Built-up area	32,916	47,499	54,462	65.5%
Total	14,768,512	14,768,512	14,768,512	

Source: Kabir et.al. (2018).

Table 1.2: Land use pattern of Nepal

Land type	By ecological zones (Percent)		
	Mountain	Hills	Terai
Agricultural land			
Cultivated	8.0	40.0	52.0
Uncultivated	15	67	18
Forest	34.0	3.0	34.0
Shrub land/degraded forest	34.0	57.0	9.0
Grassland	79.0	17.04.0	

Source: SAARC, 2008

2.2 Response to inadequate forage supply

In commercialised ruminant animal farming situations farmers compensate for shortage of forage with supplementation of expensive concentrate feed. As concentrates are expensive, animal are not fed to their requirement, thus, increased costs without any significant increase in milk, meat or fiber production. This has serious implications to competitiveness of the local products against imported products and for the sustainability of livestock production system. A relationship of feed shortage to response the production and health of the animalhas been shown in Figure 2.

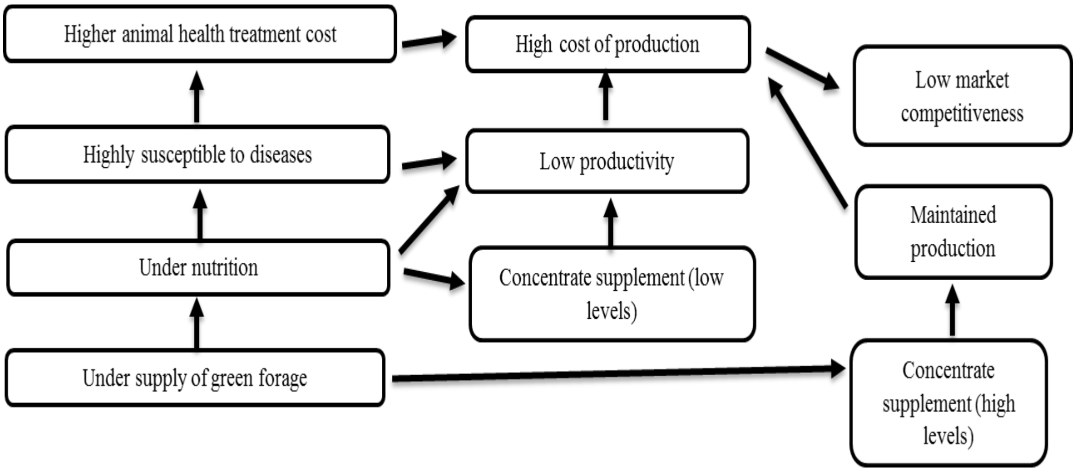

Figure 2: Response to inadequate forage supply (Ref.pp. 18 SAARC, 2008)

2.3 Feed resource available in Nepal

Several feed stuff are available in Nepal across the country (Table 2).

Table 2:Type of feed resources available in Nepal

Feed categories	**Feed resources**
Crop residue	Rice straw, wheat straw, Mize stover, pulses residue, oil crop residue, maize cobs, sugarcane tops, and bagasse.
Crop grains	Maize, wheat soybean, barley,
Crop grain by- products	Broken rice, rice bran, wheat bran, Barley bran, soybean cake, mustard cake, and molasses.
Green forage	Fodder and pasture crops as shown in Annex.
Fodder trees leaves	From forest plants and planted fodder trees as shown in Annex.

Source:NARC, 2006. Nutrient content of feed and fodder in Nepal.

2.4 Assessment of feedand nutrient available recourses in Nepal

The types of feed resources in Nepal are presented in Table 2. Crop residues, local grass, farm weeds and forest supplies make up the diet of livestock in Nepal. Agricultural land contributes about 60% of the total DM requirement and forest and grass land contributes the remaining 40 percent. Overall, Nepalese livestock are under fed at least by 33 percent.

Table 3.1 Available TDN (MT) by source

Sources of feed	Total area, ha	Available TDN, MT	Percent share
Forest	6,176,984	2,070,334	20.5%
Shrub land	341,809	177,021	1.8%
Grassland	1,253,349	255,528	2.5%
Crop residues and milling by-products	NA	4,443,642	44.0%
Farm weeds (forages) etc.	4,017,873	1,526,792	15.1%
Improved forage and pasture	67,061	694,749	6.9%
Barren area	1,534,681	92,081	0.9%
Commercial silage @40 MT/day, 70% TDN	≅ 250	4,380	0.043%
Kitchen wastes*		359,000	3.6%
Grain supplementation @5% of total TDN requirement in general		481,176	4.8%
Total TDN supply		10,104,703	100%
* At 225g/day/HH (LRMP, 1986), Rural HH in 2017 is 4,430,458.			

Source: National Animal Feed and Livestock Quality Management Laboratory, DLS, Government of Nepal

Table 3.2 :Total Digestible Nutrients (TDN) from crop residues

Major crops (000 mt)	Total production (000MT)	Grain to fodder ratio	TDN Percent	Percent Utilization	Total TDN available
Paddy	5151925	1.6	27.6	90	1840.3
Maize	2555847	2.2	25.2	30	317.9
Wheat	1949001	2.2	35.2	30	356.4
Barley	30510	0.8	38.4	50	11
Millet	313987	0.9	40.8	65	161.7
Potato	2881829	1.8	38.4	50	750.2
Pulses	368741	0.9	25.0	65	42.9
Sugarcane	3558182	-	38.0	80	79.2
Oilseeds	245867	1.2	28.0	65	33
Total TDN available from crop residue					3592.6
Percent of total TDN required					30.22

Source: MOAD, 2018, SARC, 2008 Pp 17.

As shown in above Figure 2, Inadequate feed resources, both qualitatively and quantitatively are serious constraints to increased animal production. Perspectives for the future must be sought in expanding and improving the feed base.Feed resources can be divided into following categories:

1. Low quality roughages (natural pasture, crop residues)
2. High quality roughages (fodder crops, legumes, trees)
3. Agro-industrial by-products (rice bran, oil meal, cakes and others)
4. Concentrates (compound feed of grains and agro-industrial products)
5. Supplements (vitamins, minerals and others).

In the conventional feeding regime, most of the feed energy supply for ruminants originates from rangeland, pastures and crop residues. Livestock feeding was based largely on extensive grazing on natural pastures, and to some extent on forests, crop residues and fodder crops. The estimated total fodder production in Nepal is about 6.1 million tons TDN; which meets only 64 per cent fodder requirement ofthe livestock (Pariyar, 2004).TDN available from crop residues are shown in Table 3. Feed resources available in Nepal are categorized as green fodder, roughages, concentrates, non-conventional and alternative feed resources.

Table 3.3: TDN Supply from Improved Forage and Pasture

Crop	DM yield MT/ha	Area, ha	Dry matter production, MT	Total TDN production, MT
Berseem	6.4	6,031	38,598	24,703
Oat	6	14,058	84,348	53,983
Winter vetch	3	241	723	427
Teosinte	17	27,232	462,944	291,655
Joint Vetch	5	440	2,200	1,430
Stylo & Others	15	1,010	15,150	8,030
Molasses & Others	4	180	720	374
Napier	60	7,903	474,180	270,283
Broom	9.5	2,480	23,560	13,665
Setaria, Mulato & others	10	1,696	16,960	11,024
White clover	4.8	5,790	27,792	19,176
		67,061	**1,147,175**	**694,749**

Source: National Animal Feed and Livestock Quality Management Laboratory, DLS, Government of Nepal 2019

Estimated feed demand (TDN)

Total TDN demand of livestock in 2016/17 is estimated at 12.257 million MT (Table 9). This demand is 1.3 times higher than 9.461 million MT as reported by Rajbhandary and Pradhan (1991). The large ruminants occupied about 83% of total TDN requirement in the country. Of the large ruminants, the share of cattle was the highest followed by buffalo. The share of small ruminants was only 6.6%, of which goat occupied 94% and the rest by sheep. Pig and poultry each occupied below 5% of total demand.

Table 3.4 Estimated TDN Demand by Livestock in 2016/17

Livestock Species	Population (young + adult)	LU	TDN requirement, MT	Percent share of feed demand
Cattle, including bullocks	7,302,808	4,236,873	4,780,656	39.0%
Buffalo, including bullock/bull	5,168,809	2,560,020	2,804,792	22.9%
Milk production		NA	2,496,166	20.4%
Yak/Nak	69346	49,456	54,154	0.4%
		Sub-total	**10,135,768**	**82.7%**
Goat	10,986,114	687,971	753,328	6.1%

Sheep	800,658	45,766	50,113	0.4%
		Sub-total	**803,442**	**6.6%**
Horse	68711	68,874	75,417	0.6%
		Sub-total	**75,417**	**0.6%**
Pig	1,291,308	NA	584,984	4.8%
		Sub-total	**584,984**	**4.8%**
Poultry	68,630,638	NA	551,529	4.5%
Duck	392,255	NA	8,018	0.1%
		Sub-total	**559,546**	**4.6%**
Fish, MT	56,575	NA	97,725	0.8%
		Sub-total	**97,725**	**0.8%**
		Total	**12,256,882**	**100%**

Source: NAFLQM, 2019.

Feed Balance TDN) at National Level

The above analyses (Table 5&9 above) could be summarized in the form of feed balance sheet as given in Table 10. The data in this Table indicates that the livestock requirement for TDN exceeds the supply by 17.56% of total available TDN. This deficit figure is much lower (-30.9% vs -17.56%) than estimated by previous studies (Rajbhandary and Pradhan, 1991) and by other authors (Shrestha, 2000). The difference is associated mainly with increased crop production since then and possibly with the differences in set of assumptions used.

Table 3.5 Feed (TDN) Balance

Requirement, MT	12,256,882
Supply, MT	10,104,703
Balance (+/-), MT	(2,152,179)
Percent deficit	-17.56%

To meet this demand and the growing demand in future, DLS should be implementing massive forage development program in a strategic way. Otherwise, the livestock will be competing with human foods for augmenting their nutritional demands. For example, while Nepal produced 898,115 MT of surplus edible cereals in 2016/17 (MoALD, 2016/17), it also imported similar amount (769,832 MT) of cereals and products in the same year. These two combined together made up about 26% of total cereal production. These extra cereals were not only used for human consumption but were also used for breweries (including home brewing) and as livestock feed supplements.

Import of feed ingredients and their By-products

The poultry industries in Nepal used 745,429 MT of feed ingredients during 2073/74 (Table 3.4), of which 75% yellow maize, 99% of soybean came and 90% each of sesame cake and mustard cake were imported. While the import of de-oiled rice bran and oil cakes were mainly due to short supplies in the country, the import of maize[1] was mainly associated with the poor quality of local production. Most of the local maize is cultivated during the summer. The crops are harvested during pre-monsoon when farmers are engaged in other farm businesses. At the same time, there are no facilities at local level for proper threshing, cleaning, drying and storage. Therefore, the local maize grains are

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considered low in quality for poultry feed production and at the same time are suspected for high level of infestation with aflatoxin possibly *Aspergillus flavus.* Therefore, the feed industries used the imported high quality maize even if they were more expensive than the local maize. The TDN value of these imports is about 381,735MT for 2073/74.

Table 3.6: Feed Ingredients Imported by Feed Industries and their TDN Values

Feed ingredients	Quantity Used (2073/74), MT	Percent Import*	Amount Imported	% TDN content	Total TDN, MT
Yellow maize	391538	75%	293,654	87%	255,479
Rice polish /bran	37648		-	67%	-
De-oiled rice bran	30118	30%	9,035	55%	4,969
Wheat	30118		-	80%	-
Wheat Bran	7530		-	67%	-
Molasses	15060		-	72%	-
Soybean meal/soybean	120471	99%	119,266	78%	93,028
Sesame cake	22589	90%	20,330	71%	14,434
Mustard cake	22589	90%	20,330	68%	13,824
Bone meal/Meat and Bone Meal	37648	95%	35,766		-
Lime stone	15060		-		-
Fed supplements	15060		-		-
	745,429		498,381		381,735

Source: Nepal Feed Industries Association, Kathmandu 2074

2.5 Feed requirement in project districts

The feed requirements in different districts, state wise helps to develop the feeds and fodder in the project districts. The TDN requirement have been estimated for large and small ruminant and based on Animal Unit (AU). The available crop residues production have been estimated using the grain production data. While estimating the nutrient requirement to each animal species in each district. The animal population have been converted in to AU. Each AU require 1.11 mt TDN annually and this figure has been used to calculate the total nutrient requirement (TDN). To make easy to DLSU to run the program, the nutrient requirement have been calculated considering the (1) population in the district and (2) animal Species. The TDN from crop residue have been calculated considering the grain: straw ration. Whatever the nutrient is deficit, need to supply from the green grass and crop grain by-products such as rice bran, wheat bran, oil cake, Chunkiest from grain legumes, and other non-conventional feed resources as discuss under the fodder section of this document. The nutrient balance situation in the project districts have indicated that NLSIP need promote fodder resources such as (1) forage include rangeland pasture (2) fodder trees including agro forestry and hetero-pastoral system. NLSIP districts, in Terai and Hills have is potential to grow minor non-conventional feed resource such as hornless cactus, algae, and Moringa, azolla and other non-conventional fodders.

2.5.1 Feed requirement in State 1(DLSU Biratnagar Sector):

The project districts in State Number 1 are Hills: (1) Panchthar, Ilam, Dhankutta, Udayapur (2) Terai: (1) Jhapa (2) Morang and (3) Sunsari. Cattle in Terai district are more in Terai compared to the hills. In the mountain, Yak and Chauri are kept in mountain districts of State One and feed requirement has also been estimated for Yak and Chauri. Feed requirements for ruminant animal for each project district have been separately calculated (Table 4). This will help to DLSU to work out feed and fodder development activities.

Table 4: Feed requirement in State 1

Animal Species	Agro ecological zone	Animal Numbers	Total Animal Unit	Total TDN Requirement (mt)
Cattle	Hills	475851	314537.511	349136.64
	Terai	930807	615263.427	682942.40
	Total	14,06,658	929800.938	1032079.04
Buffalo	Hills	475851	397335.6	441042.5
	Terai	930807	777223.8	862718.4
	Total	1406658	1174559	1303760.9
Goats	Hills	698165	62276.32	69126.72
	Terai	539547	48127.59	53421.62
	Total	1237712	110403.9	122548.3
Sheep	Hills	2766	247.0038	274.1742
	Terai	5188	463.2884	514.2501
	Total	7954	710.2922	788.4243
Chauri	Mountain	1248	2870.4	3186.144
	Total	1248	2870.4	3186.144

Note: Districts wise animal population and feed requirementis shown in Annexure 1.

2.5.2 Feed requirement in States 2 and 3 (DLSU Hetaunda Sector)

The feed requirement in DLSU Hetaunda (State 2 and 3) is presented in Table 5. The project districts in State 2 and 3 are (1) Saptari (2) Siraha, (3)Dhanusha, (4) Kavrepalanchok, (5)Kathmandu, (6) Makwanpur, and (7) Chitwa. These districts are potential to grow fodder and forage crops both during summar and winter. Because good road connection, the feed can be transported from one place to othe except some deficuktu are in Kavrepalanchok and Makwanpur (Table 5).

Table 5: Animal feed requirement in NLSU working state 2 and 3 (DLSU, Hetaunda)

Animal Species	Agro ecological zone	Animal Numbers	Total Animal Unit (AU)	Total TDN Requirement (mt)/year
State 2				
Cattle	Terai	460210	304198.81	337660.68
Buffalo	Terai	460210	384275.4	426545.6
Goats	Terai	557152	49697.96	55164.73
Sheep	Terai	4482	400.2426	444.2693
Total	**Terai**	**1482054**	**738572.4**	**819815.3**
State 3				
Cattle	Hills	316031	208896.491	231875.11
	Terai	316031	208896.491	231875.11
	Total	632062	417793	463750.2
Buffalo	Hills	316031	263885.9	292913.3
	Terai	73742	61574.57	68347.77

Animal Species	Agro ecological zone	Animal Numbers	Total Animal Unit (AU)	Total TDN Requirement (mt)/year
	Total	389773	325460.5	361261.1
Goats	Hills	639941	57082.74	63361.84
	Terai	213068	19005.67	21096.29
	Total	853009	76088.41	84458.13
Sheep	Hills	5388	481.1484	348.6736
	Terai	3900	349.284	253.5062
	Total	9288	830.4324	602.1798
Total	**Hills**	**1277391**	**530346.2794**	**588498.9236**
	Terai	**606741**	**289826.015**	**321572.6762**
	Total	**1884132**	**820172.2944**	**910071.5998**

Note: Districts wise animal population and feed requirement is shown in Annexure 1.

2.5.3 Feed requirement in State 4(DLSU Pokhara Sector):

The nutrient requirement in State number 4 is shown in Table 6. State 4 is having three agro ecozones such as (1) Terai (2) Hills and Mountain (trans- Himalayan region. Considering the eco one, fodder production and range pasture production needs to be promoted. Still the mountain districts do not have the adequate road network and that need feed procurement from other hill and Terai districts. Development of rangeland is very potential and pasture crops are also been identified and discussed in the document in the related chapter.

Table 6:Feed requirement in state 4

Animal Species	Agro eco zones	Numbers	Total Animal Unit (AU)	Total TDN Requirement (mt)/year
Cattle	Mountain	10966	7248.526	8045.863
	Hills	214215	141596.115	157171.687
	Terai	68810	45483.41	50486.5851
	Total	293991	194328.1	215704.1
Buffalo	Hills	163372	136415.6	151421.3
	Terai	399023	333184.2	369834.5
	Total	562395	469599.8	521255.8
Goats	Mountain	42357	2964.99	5568.137
	Hills	598966	53427.77	59304.82
	Terai	48127	4292.928	4765.151
	Total	689450	60685.69	69638.11
Sheep	Mountain	12547	1120.4471	1243.696
	Hills	44795	4005.2562	2897.13
	Terai	4816	431.32096	478.7663
	Total	62158	5557.024	4619.592
Total	Hills	1021348	335444.7412	370794.937
	Terai	520776	383391.85896	425565.0024
	Total	1542124	718836.60016	796359.9394

Note: Districts wise animal population and feed requirement is shown in Annexure 1.

2.5.4 Feed Requirement in State 5(DLSU Butwal Sector):

The nutrient requirement in State 5 is shown in Table 7. This state is very potential to grow the fodder crops that can be supplied to the districts of state four. The state is very potential to develop the TMR and silage faculties. Wheat straw is sufficiently available, and even burning. This can be save process and transport to the other districts. Except Kapilbashtu. Other districts are having irrigation facilities and fodder can be produced both in summer and winter.

Table 7:Feed requirement in state 5

Animal Species	Agro-eco Zones	Numbers	Total Animal Unit (AU)	Total TDN Requirement (mt)/year)
Cattle	Hills	163372	107988.892	119867.67
	Terai	419706	277425.666	307942.489
	Total	583078	385414.6	427810.159
Buffalo	Hills	163372	136415.6	151421.316
	Terai	399023	333184.2	369834.462
	Total	562395	469599.8	521255.778
Goats	Hills	449405	1105851	1227494
	Terai	670493	59807.98	66386.85
	Total	1119898	1165659	1293881
Sheep	Hills	10247	917.72132	1018.671
	Terai	39397	3528.3953	3916.519
	Total	49644	4446.117	4935.19
Total	Hills	786396	1351173.21332	1499801.657
	Terai	1528619	673946.2413	748080.32
	Total	2315015	2025119.45462	2247881.977

Note: Districts wise animal population and feed requirement is shown in Annexure 1.

2.6 Crop residue based feed resources available in NLSIP (State level)

The status of overall crop residues production in the project district is summarized in Table 8. The residue production of major crop such as rice straw, whet straw, corn stover, millet straw, and pulses straw in different stat have been summarized. The information will be useful to promote the fodder crop in the districts.

Table 8 Crop residue production in project districts (total of NLSIP districts only)

Crop Residue	Roughages dry production (mt/h)				
	Rice straw	Wheat straw	Corn Stover	Millet Straw	Pulses Straw
State 1	1090091.2	147,427	366102	54771.3	3461.4
State 2	869296	85,468	10460	1649.2	381.6
State 3	347118.4	72,756	188,569	18004.4	696.6
Sate 4	332393.6	36736	216,862	86425.3	2981.7
State 5	1226534.4	295940	169117	0.408	1033.2
Total	3865434	638,327	951110	160850.6	8554.5

Authors calculation 2019 based on MOALD census 2018.

2.6.1 Available TDN based on crop residue production in project districts

The TDN available in the project districts is summarized in Table 9. The estimation of nutrient is comparable to ANZDEC Report 2002. And SAARC Publication: "Best Practices in Animal Feed Production and Management in SAARC Countries, Pub. SAARC Communication Center 2008 Pp 1 to 74 Nepal Chapter.

Table 9. Available TDN based on Crop residue production in project districts (total of NLSIP districts only)

Crop Residue	TDN Production (mt)					Total Available TDN (mt)
	Rice straw	Wheat Straw	Corn Stover	Millet Straw	Pulses Straw	
State 1	300865.171	114167	202966.9	22346.69	865.35	641211.111
State 2	239925.696	66186	5799.024	672.8736	95.4	312678.9936
State 3	95804.678	56342	104542.7	7345.795	174.15	264209.323
Sate 4	91740.634	28448	120228.3	35261.52	745.425	276423.879
State 5	338523.494	229176	93758.46	11825.6	258.3	673541.854
Total	1066860	494319	527295.4	77452.48	2138.625	2168065.161

2.6.2 TDN balance in NLSIP project (Statewise) from crop residue

The crop residue are major feed resources in Nepal and even in project districts particularly in the Terai and Hills of the country. The crop residues are able to supply core total 3855381.908 mt of TDN in the project districts. Only 65 to 90 percent TND in crop residues is available to the ruminant animal. The TDN from wheat straw is only 30 percent utilized (ANZDEC, 2002) while rice straw can have 90% TDN utilization. This has indicated that there is a need of more fodder production to meet the requirement of the ruminant animal in the NLSIP project districts (Table 10).

Table 10: TDN balance in NLSIP project (Statewise) from crop residue

State	Animal Unit (AU) per year	TDN Required Mt/year)	TDN Avail from crop Residue (mt/year)	TDN Deficient (mt/year)	Need from fodder (mt/year)
State 1	2218344.53	2462362.808	641211.111	1821151.697	1821151.697
State 2	738572.4126	819815.4	312678.9936	507136.4064	507136.4064
State 3	820172.3424	910391.3	264209.323	646181.977	646181.977
Sate 4	730170.6	810489.4	276423.879	534065.521	534065.521
State 5	919268.497	1020388	673541.854	346846.146	346846.146
Total	5426528.382	6023446.908	2168065	3855381.908	3855381.908

2.6.3 Local price of feed ingredients

The existing feed ingredients price at Pokhara was studied collecting the information from three suppliers in Pokhara. These supplier applied proposing the costs to supply the feed ingredient to the government farm "National Animal Breeding Office, Malrpatan, Pokhara: 2019. The price proposed by supplier was negotiable. The price of feed ingredients is increasing every year (Table 11). There is a clear indication that feed ingredients in market is fluctuating from year to year and supplier to suppler. If the famer do not have the bargaining power, they will be cheated in feed ingredients price

Table 11: The existing market price of feed ingredients in Pokhara as provided by NLBO Pokhara

Feed ingredients	Price of Base year (NRS/kg)	Prices of Fiscal Year (2019)			Average cost (NRs/kg) of 3 firms in Pokhara	Negotiated Price to supply the feed ingrediens (NRs/kg	Price difference (Price proposed – agreed %)
	2017/18	Suman Enterprises , Pokhara	Chandan Khaddyanna Suppliers, Pokhara	P.R. Brothers, Pokhara			
Yellow corn	27.75	42.75	43.0	42.5	42.75	33.0	22.80
Wheat Bran	32.0	36.25	38.0	36.5	37.08	33.0	11.00
Rice bran	27.0	36.9	35.0	37	36.30	28.00	22.86
Oil seed cake	29.9	37.0	35.0	36.7	36.23	31.00	14.4
Deoiled rice bran	21.75	29.5	30.0	28.75	32.75	23.00	29.77
Sunflower cake	36.0	55.5	50.0	54.9	53.47	38.00	28.93
Soybean cake	61.9	70.0	70..0	39.5	59.83	64.00	-6.96
Marble grit	7.5	10.0	10.0	9.75	6.92	9.00	-3.0

Source: National Animal Breeding Office14.4 to 29.77 percent. (NLBO), Malrpatan, Pokhara, 2019. (1) * Approved cost of feed supplier after negotiations.

2.6.4 Price of compounded feed (NRs/ kg)

The existing price can be reduce if it is managed by the dairy cooperatives and will have the excess to the milk produce as they are daily selling milk to the local dairy (Table 12).

Table 12: The local selling price of the compounded feed

Feed industry	Mash Feed	Pellet Feed
DDC Cattlefeed	40.0	45.0
Nimbas	40.0	44.0
Local manufacturing	35*	NA

Note: * Local manufacturing cost of feed is NRs 35, as cost of ingredients have increased in the recent days, but mineral are not included.

2.6.5 Feed contamination and Aflatoxin in Animal Feed in Nepal

Several contaminants are affecting the feed quality in Nepal and the Aflatoxine contamination is also a serious problem in Nepal (Goutam et al 2008). Major feed ingredients such as corn, soybeans are badly affected by Aflatoxin in Nepal. The maize, soybeans and ground nut are may pose significant threat of aflatoxin in both animal and human health (Goutam et al 2008). To reduce the aflatoxin, farmers, and consumer need to be educated. Afeed Act 2033 need to be amendment to improve the feed quality. Assessment of Aflatoxin in Kathandu valley showed the presence of Aflatoxin B_1 feed used in Neap are reported by DFTQC, Nepal.

2.7 Feed and Fodder Resources

2.7.1 Green fodder

Nepalese farmers collect locally available grasses - fodder trees andgreen fodders to meet the daily dry matter need of the ruminants. However, recent trend is to cultivate improved fodder species such as Napier, Mulato, Stylosanthese and Berseem as well as peas and oats. Uncultivated grass species are locally available herbs and shrubs.More than 50 species of improved leguminous perennial and annual forages have been introduced in Nepal that has increased quality value in feeding management. Stylosanthes, Butterfly pea, Glysine and Centrocema are popular legume species along with vetch and improved fodder legumes such as *Leucaenaleucocephala*. Legumes are important in the feeding management as Nepalese farmers often rely on the leguminous species to replace costly concentrates, majority of which are imported. Season wise production of legume and cereal green fodders in different zones of Nepal are given in **Annexure 2.**

Forestry, crop farming and animal husbandry, whichcontribute about 40 percent of livestock feed is derived from the forests and trees grown on farms. There are about 700 fodder trees species widely available across the country, whereas more than 30 species are widely farmed in the community as well as private farm land in Nepal. Leguminous as well as non-leguminous fodder trees are widely cultivated in the country with the feeding scope during hard winter period. Even animal in the high altitudes are supplied with fodder trees during winter season. Major selected top fodder trees species in the project districts and reason for selection of fodder trees are described in **Annexure 3.**

2.7.2 Crop residues

Crop residues covers large parts of animal feeds in all ecological domains and areas. Approximately 40% TDN comes from crop residues that animals are grazed in the crop field after harvesting main crops for human foods. This type of feed resource is temporary in nature but widely prevails all over the country. Major crop residues are rice straw, wheat straw, corn straw, millet straw, soybean straw, black bean straw, and arhar straw

2.7.3 Concentrate feeds

Nepalese livestock species are traditionally reared on low input systems hence often no concentrates are used unless it is absolutely required. Oil seed and cakes are mainly used in the commercial or intensive type of rearing, whereas, subsistence system of rearing is supported with liquid slurps (i.e.Khole) and locally made concentrates that are rich in by-products of cereals. Oilcakes are only valued for poultry ration formulation and for intensive system of milk production for graded and crossbred animals.Regional availability and requirement of TDN for ruminant animals are given in Table 13. It clearly indicates that deficit of TDN is @ 26.5, 50.2 and 17.5% in high hills, mid hills and terai regions, respectively. The country level deficit is found @ 36.2% (Pariyar, 2005).

Table 13: Availability and requirement of TDN for ruminants (‘000 tones)

Particular	High hills	Mid hills	Terai	Nepal
Requirements				
Cattle & Buffalo	999	4458	2864	8321
Sheep & Goat	240	718	340	1298
Total	1239	5176	3204	9619
Available TDN from				
Crop byproducts	107	981	1783	2870
Non-cultivated inclusion	104	466	127	697
Forest, Grazing and Shrubland	700	1133	732	2565
Total TDN	911	2580	2642	6132
Balance	-328	-2596	-562	-3487
% Deficit compared to requirement	**-26.5**	**-50.2**	**-17.5**	**-36.2**

Source: Pariyar, 2005

As mentioned earlier, livestock in Nepalese farming system is largely extensive in nature with maximum possible use of agricultural by-products that are seasonal in nature. Often roots of perennials and their by-products are used to prepare liquid slurps to feed pigs that are reared at small scale. Animal source of feeds are conventionally used only for intensive livestock farming.

2.7.4 Non-conventional feed resources

Besides conventional feed stuffs, non-conventional feeding stuffs are also popular in Nepalese livestock feeding management. Lots of local species that are valued in terms of feeding purpose and are available in the terrace risers and bonds but are neglected, often used in feeding animals. Besides, husks of maize cobs, rice straws, millet straws, sugarcane tops and molasses are also considered as source for animal feed.

Across the agro ecological zones in the project districts, more than 60 different non-conventional feedstuffs are available that have been regularly used to feed the animals exclusively or as supplement. These are fodder leaves, crop residue, vegetable leaves, fruit peels, eggs shell and other similar type of feed items. Among these, farmers need to be careful while feeding vegetable leaves as vegetable plants are treated with insecticides in heavy doses that could be lethal to animals if fed in excess amount. Farmers need to take careful attention while feeding the pesticides treated vegetable by-product to their animals to protect the pesticides residue effect on the animal body and in products like milk and meat. In the recent days, organic vegetable farming is coming up that would support the use of vegetable plants for animal feeding as alternative feed sources.

2.7.5 Alternatives feed resources

Alternative feed resources such as green algae, hydroponic feed resources, insects, poultry faeces can be used to feed livestock. The Food and Agriculture Organization (FAO) of the United Nations estimates that commercial feed production will need to increase by 70% by 2050 to meet the growing demand for protein. Developing sustainable aquaculture systems, in particular, is becoming increasingly critical as we look for healthy and affordable sources of protein: the World Bank estimates that by 2030 nearly two-thirds of seafood will be farm-raised.

This is a huge opportunity for the Insect-for-feed (IFF) industry and makes aquaculture a target market for many Insect-for-feed (IFF) start-ups. Promotion of fish farming supports to get the quality protein source to prepare animal feeds. As sericulture farms are getting popular, sericulture by-products can be good alternative feed resources to feed to the animals as good alternative protein sources, and this can be an innovative work in this field.

Table 14: Requirements and availability of feed ingredient inNepal

Ingredients	Requirements (million tons/year)	Production (million tons/year)
Wheat	694	18
Maize	3047	217
Millet	2079	3
Barley	278	0.34
Rice	464	50
Soybean	283	0.28
Other pulses	289	2.9
Total	**7134**	**291.52**

According to Table 13 and 14 it is clear that the requirement of feed ingredients is almost more than double than the actual production of feed ingredients in the country. According to Pariyar (2004) the shortage of feed has been a major problem for dairy farmers and it is estimated that the shortage of feed in Nepal is about 36%, ranging from 18 to 50% in the various agro-ecological zones. The magnitude of problem varies but is higher in mid-hills (50%) followed by Mountains (27%) and Terai (18%).

This clearly indicates heavy reliance on importing these ingredients as production is not sufficient to meet the requirement. Among the ingredients produced, contribution of rice and wheat is less than 5% of the requirement, whereas, the production of other ingredients are far below the need. This fact also highlights that present scenario of production and utilization of cereal and pulses in feed preparation heavily challenges the food requirement for human population which is already deficit in nature.

Therefore, continued approaches of using major cereals in feed preparation must be re-thought; perhaps there is a need of sound feeding management thorough utilization of crop residues, forest resources, and other roughages and fodder forages rather than paying attention to the higher production and utilization of cereal and pulses ingredients. In addition, these resources need to be supplemented with deficient minerals by supplementing the diets with mineral mixture. Also, these feed resources and minerals need to be fed in right proportion to improve milk production and reproduction efficiency and enhancing net daily income of milk producers.

2.7.6 Local price of fodder and tree foliage in project districts

Now, there is practices to sale the forge and fodder leaves in the local market. A field survey and review of past work have shown that selling fodder can also support the livelihood of the people

Case Study 1
(Fodder selling at Udayapur Gaighat)

On 29 August 2017, a study was conducted in Udayapur Gaighat,about the local selling of fodders in the markets. The business was done early in the morning, as municipality do not allow to sale any agriculture commodities on the road during day time. There were 15 to 20 farmers selling fodders by collecting from their own farm and neighbour farmer. They were selling the fodder to the local buyer at the rate of 20 NRs per Mutha (5 kg weight) of green fodder. Mr. Santa Basnet was doing this business since last 5 years. The demand of such type of fodder is very high and increasing but he has limitation that he cannot get adequate fodder twigs for sale. Each day he is selling 150 bundle (5 kg/budle @ NRS 10) of fodder and earning NRs 1500/per day. Further, local fodder producer are also interested to sale the fodder but they not have the allocated land convenient for them and selling fodder with the fare of Municipalities personnel (Figure 3). NLSIP can support these farmers to promote fodder production and marketing to support their livelihood. Mr. Bashnet is also interested to sale other cultivated forge (annual and perennial) is forage marketing network, local market, There is market for forage and fodder twigs is supported by the project.

Figure 3: Fodder selling at Gaighat, Udayapur (Photo by Chet Raj Upreti 2017).
There is market for forage and fodder twigs is supported by the project the existing price of fodder selling is NRs (1) Napier: NRs 3(2) Berseem: NRS 5 (3) Oats NRs 4.

2.7.7 Livestock feeding systems

2.7.7.1 National scenario

Nepalese farming system is typically crop-livestock integrated in nature where role of livestock is pivotal in supporting the livelihood of Nepalese people. All types of livestock species including ruminants, non-ruminants are reared in across the ecological domains where feeding management is often traditional in nature. Forest, crop lands, crop residues, stovers and by-products are major feed resource in Nepal. The role of these sectors are seasonal in nature especially while contributing to the feeds needs of the existing species. Livestock feeding system is not constant in terms of seasons as well as ecological belts. Winter is the hard hit season to supply feeds whereas lush of feeds and feed by-products are available during summer time. The role of conservation fodder is minimal in overall to manage feed requirements and supply.

Figure 4: Observation of feeding and management at farmer's field at Patlekhet, Kavrepalanchok

Fodder trees play pivotal roles in feeds management during winter hard period as more than 100 fodder species are domesticated in the country. Leguminous as well as non-leguminous fodder trees are common in practice. Hundreds of improved fodder species including perennial legumes are introduced in the country that has increased access to the feeds and feeding management in the country. Government current policy is friendly and practical that aims to manage sustainable feeds utilization and resource use through proper management.

Existing feeding systems under different production/management systems in Nepal could be named as:

1. Crop residue based feeding system incorporating seasonal forages.

2. Crop residue based feeding system incorporating seasonal fodder tree leaves and unconventional feeds.
3. Crop residue and agro-byproduct based feeding system incorporating seasonal forages and legumes.
4. Crop residue, agro-byproduct plus concentrate based feeding system incorporating seasonal forages and legumes.

Observations on feeding and management have been taken from the farmer's at Patlekhet, Kavrepalanchok(Figure 4).

Main livestock feeding systems of small and large ruminants, prevalent in different agro-ecological zones of Nepal are described in **Annexure 4 (4.1 to 4.51)**.

2.7.7.2 Livestock feeding system in the project districts (selected districts)

A quick survey was done in selected project districts, one district in each agro ecological zone were selected to do the case study. The main aim was to document the available feed ingredient and (2) status of knowledge to balance the ration using the locally available feed resources.

Case Study 2

Typical feed resources and feeding system used in Mountain Region

(Tri – Brothers Cattle Farm, Bhalu Khop, Surytodaya Na.Pa, Ilam)

The farm is semi-commercial where 10 lactating HF cattlehave been reared. This farm is using silage bags imported from Sarlahi. Four kg of silage per day /d/animal have been fed the animal. The owners are trying to meet the nutrient requirements but diet deficient the protein source. The average milk production is 11 kg which is two kgmore compared to the national average of 9 kg. With the experience of Dr. Trivedi, the cattle are of potential to produce average 15 -20 kg milk if animal are well managed. Mineral supplementation was done but not in routines as per the requirement. Only to the freshly lactating animal were supplanted with mineralsimported from India.

The existing yield gap is of 5-8 kg/animal /day that can be exploited with proper feed and feeding.

Amrisho feeding is practiced as a sole diet in most of the farm and that need to be discouraged.

The diet itself is deficient with protein as oilseed cake and soybean based diet is less in use. A simple supplementation of diet with

1.Feed Resource

Figure 5:Feed ingredients used in farm

Figure 6: Hay transported from Sarlahi

cakes can fulfil the requirement.

Suggestion to the farmers:

1. Use Amriso as recommended quantities.
2. Try to purchase silage from nearby district like Jhapa.
3. Use mineral mixture as per recommendation.
4. Take care calves to improve the herd.
5. Adapt the Ration balancing Program
6. Dispose the manure in the crop field.

Figure 7:Well fed cattle with machine milking at Ilam

Case Study 3.
A typical Feed resources used in hill farming system
(Patlekhet, Kavrepalanchok)

Case study of two types of farm is presented here.
(1)Small Scale dairy mixed farm)

3.4. Gap Analysis on the feeds and feeding

3.4.1. Feed resource practices:

(a) Feed resources are not available as required by the animal

(b) After maize harvest, land were left fallow that could be used for green fodder cultivation.

(c) Crop residue we not camped and left open in the ground exposed to the sun and is the cause of low nutrient.Insecticide sprayed vegetable leaves and stalks have used as conventional feedstuff that need to be discourage,

3.4.2. Feed balancing and use

(a) Farmers were not aware about the importance of balanced ration and were not able to mixedthe available feed resources in proper way

(b) Farmers were grinding the pelleted concentrate feed and mixed with other feed ingredientsand cooked and that is not a good practices. .

(c).Calves were fed with small quantity of corn flour and some green fodder, and were notreceiving sufficient nutrient as they required. Pellet feed were ground, cooked and fed to the calves that is responsible to destroy the nutrients.Such practices need to be discouraged.

3.4.3 Fodder processing and conservation

Fodder conservation as silage is only practiced in

2.1.Feed Resource

Figure 8: Feed resources used at Patlekhet

Figure9: Pelleted feed was grounded and cooked at commercial dairy farm, Patlekhet, Kavre

commercial dairy farm, but not adequate to feed to the animal. Crop residue were fed un-chopped such as rice straw, corn stover and millet straw.

4.0 Goat Feeding and Management

Dairy farmers were also having 3 to 5 goats. Only the lactating pregnant doe at advance stage were offered small amount of locally made concentrate feed of two mutti i.e. about 100 gram which is far below the requirement. A normal concentrate to be offered is about 250 gram. There is gap of more than 100 percent in offering the feed to the goat. Feed are offered on ground and contaminated with faeces. There is high refusal of forbs as contaminated feed are not liked by goats. Use of improved feeder, (as made by NARC) can be helpful to reduce the wastage of feed and save from contamination. In mixed farming system, lactating cattle and buffaloes are more taken care than goats. Use of feeder reduce the parasitic load in the gastro intestinal tract. Goat fed in fodder recorded 50% lower parasitic load compared to ground fed goats (Swisscontact 2019).

Figure10: Goats in mixed farming fed on ground without/with little concentrate feed

Case Study 4

A typical Feed resources used in Terai

(Mr. Bishnu Pd, Gyawali: Debdaha VDC, ward No 7, Sunkauda, Rupandehi

A typical farm managed by Mr/ Bishnu Pd. Poudel at Devdaha, Rupandehi. Farm is well managed using locally available feed ingredients. Whatever available in hose were well processed mixed and fed to the animal. Improved HF and Jersey cattle are maintained. Despite of the congested space. Mr. Gyawali is able to produce more milk as feed was better mixed considering the proportion. The mixing ration was better compared to other local farmers in the in the locality. The farm owned 5 kattah of land for fodder cultivation. A fodder crop calendar have been adapted to get the round year fodder production.

The feed used is are following;
(1) Rice straw 7 kg/animal
(2) Green grass: 15 kg
(3) home-made concentrate 1 kg
(4) purchased compounded fee: 2 kg
(3) Chokar: 1 kg
Note Mineral supplementation was used. Cattle produced 8 kg milk/day and

Need to Improve:
1.Mineral supplements: need to offer.

1.Feed Resource

Figure 11: Feed ingredients available and used in farm

Figure 12: Tried to adapt fodder

2.Feed manger: Need to design as per recommended design. 3. Discourage to use Chokar: The existing quantity of chokkar needs to be reduced from 2 kg to at least 1 kg. Farmers are preferring choker as it improve the palatability of Khole. 4.Green fodder production: Need to grow more fodder to prepare the silage using the fodder maize in available land. 5.Introducing the Ration balancing Software (RBS). Better to introduce RBS as the owner is educated and able to learn the software.	**based feeding** **2. Feeding:**  **Figure 13: Due to inadequate manger space, the concentrate is offered on floor**

2.7.7.3 Problems in feed and fodder production

Feed and fodder production in Nepal is facing with several problems.This information was collected from the State Level Interaction Workshop recently held in 4 DLSU. To identify the existing problems (1) review on the existing Available documents on feeds and fodder (2) Four State Level Workshop were conducted to collect the information on problems faced by; (1) farmers (2) feeds producers (3) feed traders (Agro vets) and (4) fodder seed grower.The major common issue and methods to solve the problems are summarized below.

1. Feed Producers (farmers related):

Major problems and suggestion as suggested but participants at stakeholders meeting in (1) Biratnagar (2) Hetaunda (3) Butwal and (4) Pokhara has been summarized in following Table 15.

Table 15: Major problem faced by the stakeholder and suggestion to solve the problems

Related stakeholders	Problem faced	Suggestion to solve the problem
Feed Producers (farmers related)	(1)Shortage of land for fodder production, (2) shortage of certified fodder seed, (3) shortage of work force, (4) lack of irrigation, (4) shortage of fertilizers (5) no provision to get the loan from the bank for fodder production. (6) Open grazing during the winter in eastern Terai of Nepal.	(1) Intensive crop production needs to adapt with fodder priority (2) Provision of inputs such as fertilizer, irrigation certified seed (3) Provision of loan from the bank
Feed Manufacturers	(1) Shortage of quality feed ingredients (depending on the other countries (95% of the total requirement) (2) Impose of taxes in different level (3) Irregular supply of feed ingredients from other countries (4) In adequate government support to establish the factory.	(1) Incentives to the feed grain producer in inputs (2) Removal of excess taxes (including local) to cut down the cost of production. (3) Minimum facilities to establish the feed milk should arrange by the government

Shortage of work force and lack of mechanization program	(1) Like to other cereal crops, there is heavy shortage of workforce to involved in fodder production and conservation (2) Lac jog medium type equipment s to use in fodder production.	(1) Encourage youth and provide training to youth to grow fodder and subsidise the machinery equipment to reduce the work load to the labour force and improve on the work efficiency.
Lack of irrigation	(1)Lack of irrigation	(1) Provide the subsidies to by the pump set, other related to irrigation set up.
Shortage of fertilizers	(1) Shortage of fertilizer (2) not available in time during the crop swing season.	(1) Still the country id dependent on the importation of chemical fertilizer. (2) Make provision to make fertilizer available in time.
No provision to get the loan from the bank for fodder production	(1) Banks denies to provide the loan for fodder production	(1) Government, both local and state, should make arrangement to provider the loan for fodder production related items.
Open grazing during the winter in eastern Terai of Nepal	1) Specially in Tarai region, after harvesting the paddy, lands are open for animal grazing that is discouraging to cultivate the fodder production	(1) Encourage farmers to keep their animal in stall feeding system
Policies related to fodder and feed production	(1)Forage mission has been executed but not covered all project districts.(2) Lack of (3)Seed act 2045 B.S. and Seed regulation 2054 is applied to food grain but not implemented in both feed and feeder.	(1) Needs to revise the Seed Act that included the forage seed

2.7.7.4 Fodder production

It has been discussed in section 11.

Chapter 3
Livestock and their Productivity in Nepal

3.1 Large ruminants

Nepal has a very high population of cows and buffaloes, but the total milk production is very low (Table 16). Of the total milk production, about 70 percent is buffalo milk and 30 percent is cow milk. About 10 percent of the national milk production enters into the organized dairy market. It is likely to increase as the road network increasing at the rate of 200 km/year further develops. In Nepal, milk production has lean and flush seasons of milk production. This variation occurs due to seasonal calving by the buffaloes and better availability of fodder to milking animals during the monsoons and cooler weather conditions.

Table 16:Number of cows and buffaloes, and milk production inNepal (2017-2018)

Species	Total Number	Milking Animal (Million)
Cow	7376306	1039538
Buffalo	5277819	1535948
Total	12654125	2575486

Source: MOALD 2017/18

3.2. Reasons for low production and sub-optimal reproduction

Deficiency of protein and energy is considered as one of the major reason for the sub-optimum performances in improved livestock breeds in Nepal. Since the feeding of mineral mixture is rare, minerals essential for milk production (calcium and phosphorus) is significantly deficient in the ration of dairy animals. About 35 per cent of productivity is estimated to have been constrained by the poor feeding system of the livestock. In the conventional feeding system, livestock are raised under extensive pasture and grazing systems supported by a few nutritive grain supplements, particularly for dairy and meat animals.

Feed for livestock is mainly obtained from forests, grazing lands and crop lands. Of the total animal feed base, crop residues accounted for 47 per cent and forest leaves accounted for 30 per cent of the feed. The rest is from non-cultivated shrub lands and grazing land.Calculation of total feed requirement (kg/d) for each category of ruminant livestock species based on total livestock population, their proportion in each farming system and feed requirement (kg/d/animal) is given in **Annexure 5**.

Another major challenge constraining the growth of dairy sector in Nepal could be the poor reproductive efficiency of cows and buffaloes. Average age of first calving (AFC) in native, crossbred and exotic cattle is 50, 33 and 29 months, respectively. Whereas, AFC in native buffalo is observed at 68 months. Similarly, calving interval is about 18 months in native cattle and 22 months in native buffalo(Table 17). The poor reproductive status of cows and buffaloes in the country may be due to the lack of good quality mineral mixture; as the trace minerals such as copper, zinc and manganese are crucial for optimum reproduction efficiency of dairy animals.

In addition to above, there are many other challenges that hampers the growth of dairy sector in Nepal are lack of skilled manpower, inactive farmers' cooperatives, poor quality of milk produced in the rural areas, wide seasonal variations in milk production with the dominance of buffalo milk, lack of milk conservation facility, etc.

Based on the current feed resources and feeding practices followed by dairy farmers in different agro-ecological zones of Nepal, it is evident that there is an urgent need to judicious utilization of feed resources for improving productive and reproductive efficiency of dairy animals in project area. There is wide spread deficiency of essential minerals, particularly calcium and phosphorus. Thus good quality mineral mixtures need to be fed, so as to meet the mineral requirements of dairy animals.

Table 17 Reproductive and productive performance of cattle and buffalo in Nepal

Animal Species	Reproductive		Productive	
	Age at first calving (Months)	Calving interval (Months)	Average daily milk yield (lit)	Lactation length (days)
Native cattle				
Lulu (Bos Taurus)	52	18	1.6	195
Achhami	60	17	1.5	225
Siri	50	19.6	4.5	268
Khaila	55	17	2.5	305
Pahadi	50.1	17.6	1.1	240
Terai	49.9	16.3	2.1	246
Nak and Chauri				
Nak	56.6	21.3	0.8	160
Chauri	-	-	-	-
Exotic cattle				
Holstein Friesian	30	12.5	20	300
Jersey	28	12.5	9	300
Brown Swiss	29	13.5	15	300
Crossbred cattle				
Jersey cross	33	14.6	5.7	280
HF cross	30	18	6.2	280
Brown Swiss cross	34	16.7	5.2	280
Native buffalo				
Lime	61.2	21.0	3.0	305
Parkote	62.2	20.6	2.77	305
Gaddi	68.4	23.4	3.5	420
Improved buffalo				
Murrah	38	16	5.41	
Murrah Cross	52.3	45.44	4.48	330

Source: NARC 2005, (1) Indigenous Cattle of Nepal Pp 1-18. (2) NARC 2007.Indigenous Buffalo of Nepal. Pp 1-14.

3.3 Small Ruminant (Goat and Sheep)

Goats (*Capra hircus)***:**Goats are important ruminant livestock animal in Nepal.There are 11647319 goats in the country (MOAD, 2019). Every rural household maintains 2-5 goats. In goat potential pockets, the number per house hold is increased to 20-25 heads. It has been mentioned that goats are more prolific, better income generation enterprises for women and underprivileged communities. The goats in the country are kept for multipurpose uses. They provide meat, manure and drought. Further Chyangra goats, in trans- Himalayan region of Nepal: in Mustan and Manag of project districts are popular for Pashmina production. In local goats, twinning percentage is more than 50 percent and kidding per doe per year is 1.32 with 7-10 percent mortality. During the daytime, goats browse in the forest, pasture lands, paddy field, bunds risers and at the riverbanks. In the recent years, local authorities are encouraging to the goat keeper to manage the animal under the stall feeding system to protect the new plantation in the community/public forest. The existing feeding system, the FCR is 11 percent which can be reduced to 7 percent is improve in feeding system.

Goats are prolific with short generation interval, and ready (male) for slaughter in 18 to 24 months with dressing percentage (68 percent).The existing feeding and management system in NLSIP project districts indicated that (1) Goats are not fed considering the growth stage i.e. kid – hogget-breeding - pregnant- lactating –dry stage, and physiological state such as dry-pregnant- lactating – breeding stage of the animal. (2) Male goats are slaughter in early age of 12 to 15 months during the festival. With the introduction of Boer goats in the farming communities, fodder development has become crucial to protect the animal from the stunted growth. If nutrient requirement of the goat at different growth and physiological state (Table 18) is not fulfilled, the stunted weight is expected. The nutrient requirement of goats have been discussed in this report

Table18 Reproductive and productive performance of goats in Nepal

Animal Species .	Reproductive				Body weight at Slaughter (kg)	Productive performance	
	Age at first service (Months	Weight at 1st service (kg)	Age at first kidding (Months)	Kidding interval (Months)		Average dress meat production (kg)*	Pashmina production (gram/ animal/year)
1.Native Goat							
1.Terai	12.0	17.3	16.0	11.0	24	16.32	0
2.Khari	11.0	15.4	15.0	10.0	23	14.96	0
3.Sinhal	12.0	17.0	19.0	9.50	24	15.64	0
4.Chyangra	13.5	18.5	18.0	10.0	22	14.96	250
2.Improved (50% cross)							0
1.Jamunapari			24.0	9.0	26		0
2. .Barbari			18.0	8.66	24		0
3. Boer	247.5	30.0	370	8.51	65.***		0
3.Pure 100%)							0
1.Jamunapari			20.5		26		0
2. 2.Barbari			19.6		22		0
3. Boer	44.08**						0

Source: NARC 2008. Indigenous Goats of Nepal Pub. NARC, Kathmandu Pp 6 and 7.

Note: *Meat dressing percentage is 68 at 18 months of age of castrated male goat, and for Jamunapari 24 months.** weight of 12 months., *** weight at 24 months

Table 19: Small ruminant population in project districts(NLSIP districts only)

Districts	**Small ruminants**		
	Goat	**Sheep**	**Chyangra**
Manag	9611	5693	5765
Mustang	33925	6564	42771

Source: MOALMC, 2017 and Chyangra data from district sources.

3.3.1 Chyangra goat (*Capra hircus)*

Chyangra goat is reared in Trans-Himalayan region of above 3,000 m asl of Nepal. Chyangar is the source of Pashmina (down fine fibre of less than19 µ) used to fabricate high quality fiber. The goat species is reared in dry pastureland in short migration. The feed resource available in trans–Himalayan region is range forage which is available during summer.

3.3.1.1Feeding Practices of Chyangra

The entire feeding system in Chyangra region is a sedentary or transhumance system. Animals are managed in low feed inputs. The animal are basically dependent on grazing and forages of cut and carry from nearby forests. Grain or concentrate feeding/supplementation is minimal and common salt is offered at 15 days interval. Due to lack of system of supplementation of concentrates most of the animals lose weight from December to April/May. The weight gain and reproductive cyclicity during winter is affected by under feeding/malnutrition. The animal gain weight and resume reproductive activity once they achieve compensatory growth/weight gain after grazing on good pasture land during summer months. The low birth weight of the new born is associated with mating in November and kidding in April/May. The entire pregnancy period is during food scarcity period. Forage conservation like hay making needs to be practiced to solve the existing feeding problem,

3.3.2. Sheep (*Ovis aries*)

Sheep are important livestock commodity in Nepal, particularly for hill and mountains. There are 800749 sheep in the country(MOALD 2019). Only 5 to 10 percent sheep are exotic (pure and cross breed) and rest is indigenous suggesting more contributions comes from indigenous breed. The principle breed of high altitude (about 1500-2500) is Baruwal, Dkorel and Bhyanglung. In hills and Teri, kage and lampuchre are the main breed mainly for meat and manure. Bhyanglung breed and chyangra graze together in the mountain alpine pasture and reach upto the snow line in summer. During winter (September through mid-October) they come down grazing and browsing on pasture and forest even at and around village farms. Lam morality is high (up to 20%) due to (1) hard winter (2) shortage of feed and (3) attacked by predators. The milk produced by the ewe is not enough to nourish the land due to the mal nutrition. The existing feeding situation suggest the need of improvement in rangeland in the NLSIP project districts (Manag, Mustang, Pachthar, Ilam, and Kashki (potential sheep zone). Range land development and fodder production in high-mountain and trans Himalayan region support the Yak, Chauri, Bhyanlung shep, and Chyangra for pashmina production. Rangeland development is urgently needed to support the ruminant animal to support the livelihood of the people in this trans-Hilamayan region. The small ruminantpopulation in mountain (project districts is shown in Table 19.

Pasture fodder and rangeland development should focussed to consider these all there major livestock commodities in the NLSIP project districts as shown in Table 20. Thefeeding and management system including of chyangra goat, singal goat and bhyanglung sheep including chyangra has been detailed in Table 20.

3.3.3 Goat and sheep feeding and management system

During the feeding and management process, the existing production system should be considered for economic feeding and management. The feeding management is shown in Table 20.

Table 20: The feeding management system of goat/sheep farming in NLSIP project districts of different agro ecological zone (including Manag and Mustang district)

Management system	Feeding system	Feeding management
1.Trans-Himalaya and Mountain (3000 to 5000m asl) (Manag and Mustang)		
1. Migratory within (3000 to 5000m asl)	Grazing and night camping in open rangeland during summer (July to November	This system is in crisis due to (1) labour shortage and (2) local rule of rangeland management.
2.Semi migratory system	Partially stall feeding: During the winter with short movement	This system is also in crisis as above.
3. Stall-fed System	During the heavy snow fall (Jan to March	This is effective system but need more labour.
2.Mid Hills, Siwalik (500-3000 masl)		
1.Semi sedentary system	Grazing during the day in community forest goats browse in the forest, pasture lands, paddy field, bunds risers and at the riverbanks.	Goats are forced to manage the animal under the stall feeding system to protect the new plantation.
2.Stall-fed System	During the daytime, goats browse in the forest, pasture lands, paddy field, bunds risers and at the riverbanks – Goats are forced to manage under the stall feeding system to protect the new plantation in the community/public forest	Needs (1) more cultivated fodder and (2) more labour to cut and carry the fodder.(2) Helps to protect the community forest, and (3) Accumulation of manure in the shed helps to supply the manure to the crop land.
3.Tarai (Lower than 500 m asl)		
1.Semi-stall-fed System	Grazing during the day and in community forest and camped inside during night.	(1) Local authorities are forcing to keep the goats under the stall feeding system to protect the new plantation in the public land /forest.
2. Stall-fed System	Animals are camped during day and night. Goats are fed with the fodder from the field. In the recent years, semi and commercial farmers are adapting this management system that needs fodder production and conservation as hay and silage). Promotion of Boer goat in the NLSIP districts is further demanding this type of management system.	(1) This is best suited system but needs (1) more cultivated fodder and (2) more labour to cut and carry the fodder (Annex...). (2) Helps to protect the community forest, and (3) accumulation of manure in the shed help to supply the manure to the crop land

Source: (1) Khanal, B. 2011. Rangeland Management Pub. NARC. Pp 1-108., (2) Heifer International Nepal 2012.A study on Goat value Chain in Nepal. Pp Pp 1-50. (3) Poudel, S.P. Best Practices in Animal Feed Production and Management in SAARC countries Pp 4-55.

The management system as mention above requires more fodder cultivation to promote the stall feeding management system in the project district. Fodder component in this report describes the potential use of fodder for ruminant feeding. Yak/chauri/vchayangra and bhuanglung sheep are grazing in the rangeland.

3.4 Compounded Feed

Compounded feed is another important component in animal feeding system that share the input. There are four source of concentrate feed such as;

1. Locally made concentrate feed
2. Feed prepared and distributed by individual small scale feed plants
3. Feed compounded by private feed manufacturers and
4. Feed processed and distributed by government sector.

3.4.1 Locally made concentrate feed

Farmers are preparing the concentrate mixture and used to their animal mainly to the lactating animal. The feed of this categories are not balanced mixture. Whatever available in the farm house is being fed to animals. Main feed are corn flour, brans (rice wheat) and cakes. These feed items are not mixed and used to feed alone of mixing one or two items without considering the proportion of the feed items. More than 95 percent of the famer are adapting this system. But in the recent years, farmers are slowly adapting the balanced concentrate mixture to feed to their animal particularly to lactation animals. In case of small ruminants, a handful of grain/flour is offered without considering the cereal and legumefeed items.

A quick survey in NLSIP districts indicated that the existing system of concentrate feeding is traditional without considering the requirement as required to different growth and physiological state of the animal. However, some farmers are slowly adapting the concentrate feeding as supplement to their animal mixing the locally available feed items. Once milk is dropped, they are feeding locally available calcium mixture without considering the requirement of the animal.

3.4.2 Feed prepared and distributed by individual small scale feed plants

There are some feed manufacturer making some preparation such as “Makkhan Gau Aahara”at Jhapa. Only pulses grit,some rounded corn and molasses have been included, packed and distributed without any information about the nutrient composition. The so called cattle feed do not consider government regulations. This is an example, and are more in the markets. Government should stop marketing of this type of feed.

3.4.3 Feed compounded by private feed manufacturers

There are at least more than 110registered feed industries producing783701 mt animal feed out of which 8 to 10 percent is cattle feed. Majority of the feed industries are located in state number 3 and remaining are scattered across the country (Table21). None of the feed manufacturers have information about the nutrient on their feed bags. But the feed coming from India are well labelled including the minerals.

Table 21: Private feed industries in Nepal (2076); member in NFIA and Government registered

Districts	Feed Industries	Districts	Feed Industries	Districts	Feed Industries
1.Kathmandu	25	8.Chitwan	26	15.Nuwakot	3
2.Bhaktapur	10	9.Dhading	2	16Bara	2
3.Lalitpur	4	10.Kashki	2	17.Makwanpur	2
4.Kavre	6	11.Parsha	4	18. Jhapa	1
5.Kapilvastu	1	12.Morang	4	19.dang	1
6.Rupandehi	8	13.Bnake	2	Dhanusha	1
7.Sunsari	3	14Kailali	3	Total	110

Source: 2075/76/ Nepal Feed Industries Association, Kathmandu, Nepal

Figure 14: Cattle feed prepared by DDC at Hetaunda

Figure 15: Feed without Truthful lable sold at Jhapa and Ilam

3.4.4 Feed processed and distributed by government sector

Government of Nepal established Cattle Feed Plant in F.Y. 2022/2023 inSisau gharai of Hetaunda.This is the only Government Feed Mill operated in Nepal. The mill was not able to operate under the government rules and regulation, and handed over to Dairy Development Corporation in 2070/03/27. Now the feed mill is operating as “DDC Animal Feed Production Factory” and the brand name of the feed is DDC Animal Feed” (Figure 14). Currently, the factory produced only cattle feed.

3.4.5 Feed composition and quality of the government feed Industry

As the factorytechnical specification different feed ingredients are mixed and compounded and distributed to the farmers though their network. The nutrient composition in the compounded cattle feed is as shown in Table 22.

Table 22: Nutrient composition of DDC Animal Feed (Cattle feed) produced by DDC "DDC Animal Feed Production Factory, Hetaunda. Nepal"

S.N.	Nutrient composition	Amount of Nutrients
1	Moisture % Maximum	12.0
2	Crude Protein (CP), (Nx6.25)% Not Less Than	16.0
3	Fat (EE), % Not Less Than	3.0
4	Crud Fiber (CF) % Not More Than	10-12
5	Acid Insoluble Ash (AIA)% Not More Than	4.0
6	Calcium (Ca) Not Less Than	0.5
7	Common Salt (Nacl) % Not More Than	2.0
8	Phosphorus (P) % Not Less Than	0.5
9	Vitamin –A (IU) Not Less Than	4000
10	Vitamin D 3 (IU) Not Less Than	1200
11	Aflatoxin (ppb)	100

Note. Reference of DFTQC, Kathmandu) has provided the instruction facts

The CP content in the feed is of only 16 percent and as the number of high yielding dairy animal are increasing. Thus, it should be of at least 18 to 20 percent. The feed bags do not have the label of nutrient composition, which is most important (Figure 15).

3.4.6 Management of feed ingredients by the Government

The government of Nepal through have established the guidelines to be use while importing the feed ingredient from other countries. There are 36 different feed ingredient and other feed supplements that can be imported with the prior approval of National Animal Nutrition and Livestock Quality ManagementLaboratory (NANLQML) under the Department of Livestock Service (DLS), as shown in Table 23.

The list of animal feed related items that can be imported from other countries included (1) Compounded feed (2) Feed ingredients (36 types) (3) Nutrient feed supplements (4) Non nutrient feed supplements (5) Coccidiostats (6) Probiotic. This assessment suggested that government of Nepal is prepared to promote the feed and feeding of animal in the country.

Table 23: Different types of feed ingredients approved by the government to purchase from abroad

Grain & grain by products	Amino acids	Mineral	Vitamins	Enzymes	Coccidiostats	Anti-oxidants
36	3	10	14	8	9	4

Source: Gov./DLS/National Animal Nutrition and Livestock Quality Management Laboratory. Livestock Lab Bulletin, Karyabidhi Special Issue: Year 3, Number 4. 2074 Kartik. Pp 1-15.

3.4.7 Government Standards, Acts,Regulations to control the Feed Quality

There is Feed Act 1977 with amended regulation 2007, and executed by DFTQC under the Ministry of Agriculture and Animal Development with limited excess to the rural area of the country. It would be better if the quality control work is managed under the **Gov./DLS/National Animal Nutrition and Livestock Quality Management Laboratory (NANLQML)**. As DLS has its network upto the grass root (Livestock Service Centre in rural municipality under the new structure).It would be better to assign the Feed Quality Management Job to the DLS/ **NANLQML** If this provision is accepted by the government, it would help to maintain the feed quality across the country, For this, DLS should established the State Level Nutrition Quality management Lab in (1) Birtanagar (2 Janakpur (3) Pokhara (4) Nepalganj and (5) Dhangadi. These laboratories can be jointly operated with Veterinary Laboratory and should be managed by Central government incollaboration with respective State Government. The NANLQML should monitor the technical and administrate operation of the laboratories.

3.4.8 The price of feed ingredients in domestic market

The feed ingredient price in local market have been compiled for 10 years. A few business houses dominate the supply of feed ingredients in Nepal. They have almost monopoly in feed ingredient price. Two big houses hold more than ninety percent control over the supply of major feed ingredients. There are about 35 small scale ingredients suppliers and most of them work as middleman between big supplier/ big house and the feed mills and the farmers having hammer mills. The existence of small and medium sized feed industries is severely affected by price fluctuations. The price of feed ingredients heavily depends on the supply of major feed ingredients from India. Normally the average of feed ingredients is 8.5 to 12 percent higher in Nepal than bordering area of India. The major costs of feed ingredients are (1) agriculture tax (4-8%) (2) Local municipalitytax (3) costume clearance cost and (4) transportation cost. It has been well covered under the above subheading feed resource available in Nepal.

Chapter 4

Future Action Plan to develop and use of Feed resource in Nepal

The Development Objectives (PDO) of the project are to

1) Increase productivity,
2) Enhance value addition, and
3) Improve climate resilience of smallholder farms and agro-enterprises in selected livestock value-chains in Nepal.

The Project has four components: (a) Strengthening Critical Regulatory and Institutional Capacity; (b) Promoting Sector Innovation and Modernizing Service Delivery; (c) Promoting Inclusive Value Chains for Selected Livestock Commodities; and (d) Project Management and Knowledge Generation.

Following major nutritional interventions will be undertaken to achieve the above PDO in project area:

1. Implementation of ration balancing program
2. Production and distribution of mineral mixture
3. Supplementation of urea molasses mineral block in the ration
4. Chaffing of fodder
5. Enrichment and densification of crop residues
6. Compound cattle feed quality regulation
7. Green fodder production and enhancement
8. Calf rearing program
9. Greenhouse gases (GHGs) emission reduction
10. Use of bypass protein feed for enhancing milk production
11. Development of a broad spectrum toxin binder.

All above nutritional interventions have been described in details in this Assessment Report.

Chapter 5
Implementation of Ration Balancing Program (RBP)

Under the NLSIP, various measures are being suggested for implementation which would help improving the productivity of livestock, reduce cost of feeding and enhance farmer's income. The most important of these programs is the development and implementation of RBP at farmer's doorstep with the help of extension agents of various service providing organization at village level.

For this purpose, two masters will be created. One on the chemical composition of various feeds and fodders used for livestock feeding in the project districts and second on the nutrient requirement of all the livestock species that are covered under the RBP. With the help of software experts, a computerized least cost ration formulation program will be developed, based on which livestock keepers will be advised to feed a balanced ration based on locally available feed resources. This will help reducing the feed cost and/or increase the productivity. The project will be ensured to be sustainable after the financial support is over. For this purpose, extension agents will charge a minimum fee per month from the beneficiaries availing RBP services. In addition, the extension agent will also get financial support from the sale of feeds and feed supplements to the beneficiaries.

5.1 Ration Balancing Program

What is ration balancing?

All species require balanced ration for optimal growth, production and reproduction. Ration balancing is the process to balance the level of various nutrients of an animal, from the available feed resources, to meet its nutrient requirements for maintenance and production.

Concept of ration balancing

A ration is the amount of feed that is fed to livestock during a 24 hour period. When all nutrients present in a ration are as per the nutrient requirements of the animal, the ration is known as a balanced ration. A balanced ration should provide protein, energy, minerals and vitamins from dry fodders, green fodders, concentrates, mineral supplements etc., in appropriate quantities to enable the animals to perform optimally and remain healthy. In order to balance a ration properly, one must know the chemical composition of available feedstuffs, nutrient availability and requirement of animals.

The concept of ration balancing is already in place in most of the developed countries, where the feed resources are available in abundance, herd sizes are much bigger and the livestock owners are better versed with the scientific practices of feeding and management. However, in most of the tropical countries, herd sizes are smaller and dairy farmers follow traditional feeding practices, causing imbalance of nutrients in terms of protein, energy, minerals and vitamins. In view of this, the concept of ration balancing for smallholder dairy farmers in most of the tropical countries has been a challenge owing their lack of knowledge and skills.

5.2 Importance of feeding balanced rations

Feeding is the foundation of livestock systems and accounts for more than 70% of the total cost of milk production. It directly or indirectly affects the entire livestock sector, including animal productivity, health and welfare, and the environment. Feeding as per the nutrient requirement of animals, using locally available feed resources is an imperative for improving the genetic potential of low yielding dairy animals in tropical countries. Devendra and Leng (2011) have stated that the locally available feed resources act as the key driving force for improving the productivity of animals in Asia.

To maximize profitability from the dairy animals, one need to ensure that the dairy animals receive required quantity of protein, energy, minerals and vitamins, preferably from locally available feed resources. Improving production and nutrient use efficiencies through balanced nutrition approach is also one of the most promising ways to reduce methanogenesis in ruminants. It is also documented that the most relevant methane mitigation strategy for smallholder mixed crop-livestock systems in tropical countries is to increase individual animal productivity as a consequence of providing nutritionally balanced feeds (Bayat and Shingfield, 2012; Hristov*et al.* 2013).

Imbalanced feeding is widely prevalent in the smallholder dairy systems of tropical countries, like Nepal. Imbalanced feeding not only produces less milk at a higher cost, but also produces more methane per litre of milk production. Livestock fed imbalanced rations produce more methane, as most of the dietary organic matter (OM) is fermented to produce acetate and butyrate, resulting into more CH_4 production (Blummel, 2000).

5.3 Development of ration balancing program

Ration balancing program (RBP) will be developed using user-friendly, computer software for advising milk producers at their doorstep to balance the rations of their dairy animals, with the available feed resources and area-specific mineral mixtures. In this programme, a window based internet linked application will be designed to assess the prevailing nutritional status of an animal's diet *versus* its nutrient requirements. Both sets of information will be used to determine a least cost ration with the available feed resources and an area specific mineral mixture. The RBP will comprised of a feed data library and various 'Nutrition masters'. To create the feed data library, a wide range of feed ingredients such as green and dry forages, tree leaves, grains, oil cakes and agro-industrial by products will be collected from different agro-climatic regions of the country and analysed for chemical composition.

Simultaneously, existing national and international feeding standards for nutrient requirement of growing, lactating and pregnant animals will be used to create various 'Nutrition masters' of nutrient requirements(Kearl 1982; NRC 2001). Nutrient requirement for different physiological stages of cattle and buffalo (Handbook of Dairy Nutrition, Nepal,2009) is given in **Annexure 6 (6.1 to 6.12)**. The existing chemical composition of feeds and fodder available in project area will be considered for developing feed data library. The software will be compatible with desktops, laptops and net books, and can be used on personal digital assistants for areas devoid of internet connectivity.

Steps for formulating a least cost balanced ration using the software

1) Registration of animals

Animals identified for the ration balancing programme are first ear tagged with a unique 12 digit number. Details of the animals (e.g. species, breed, age, milking status, number of calving, last calving date and pregnancy status) are captured. Along with the animal's details, the owner's profiles (e.g. name, father's name, age, village, village institution, tehsil/ block, district and state) are also noted. After completing all the information, the animal is registered on the server. Animal registration is a once-only activity.

2) Assessing nutrient status of animals

After registration, the animal's daily feed intake, daily milk yield and milk fat percent are recorded. In addition, the animal's body weight (BW) is also recorded, using Shaeffer's formula as: BW (kg) = ([(heart girth in inches)^2 x length of the body in inches]/300) x 0.4536.

Based on milk yield, milk fat percent, BW and the pregnancy status, the animal's nutrient requirements is computed by the software. Considering the prevailing feeding practices (feed intake), consumption of nutrients (e.g. energy, protein, calcium and phosphorus) is assessed. This information helps in understanding the deficiencies/ excesses of various nutrients in the ration and the cost of feeding per kg of milk production.

3) Formulating a least cost balanced ration

Based on the chemical composition of available feed resources (a pre-requisite to this is the preparation of inventories of feed resources that are used in a region) and in accordance with the nutrient requirement of the animals, the software computes a least cost ration within the given constraints. Nutrient content of fodder tree, shrubs, climbers, local grasses, legumes, feed ingredients, crop residues and non-conventional feed ingredients, available in Nepal is given in **Annexures7 to 13.**

The proximate and mineral composition of different feed ingredients available in India are also given in **Annexure 14 (14.1 to 14.5)**,which can be used for implementing RBP in project area.The constraints could include non-availability or limited availability of green fodder and/or compound cattle feed, affordability of milk producers to purchase specific feed ingredients from the market, roughage to concentrate ratio, stage of lactation and type of feed offered, etc. A least cost ration, with suggested feed ingredients in proportions as indicated by the software, is designed to reduce the costs of feeding and/or increase milk production.

5.4 Benefits of Ration Balancing Program

- Uses locally available feed resources to balance the ration of animals at least cost
- Increases milk production with more fat and solids-not-fat
- Helps increase the net daily income
- Improves reproduction efficiency
- Helps reduce inter-calving period, thereby increasing the productive life of animals
- Improves the general health of animals
- Improves the growth rate in calves leading to early maturity

5.5 RBP being implemented in India

The objective of this programme was to produce an optimum quantity of milk at the least cost from milch animals by readjusting, wherever required, the proportion of locally available dietary feed ingredients, so as to provide them adequate amounts of proteins, minerals, vitamins as well as energy. The National Dairy Development Board (NDDB) of India has developed a user-friendly software for ration balancing that can be used by dedicated local resource persons (LRPs). LRP explaining about RBP to village milk producers in India has been shown as Figure 16.

Figure 16: Explaining RBP to village milk producers in India

5.5.1 Impact of RBP in India

A ration balancing program is being implemented by NDDB across the country. NDDB has implemented RBP in 18 major milk producing states of India; covering about 2.8 million dairy animals in in 40,000 villages. Large scale implementation of RBP has resulted in increase in net daily income of farmers by way of increasing daily milk yield and milk fat level, while decrease in feeding cost. Ration balancing also helped in improving feed conversion efficiency (FCE) and microbial protein synthesis, whereas, reducing enteric methane (CH_4) emissions and therefore carbon footprint of milk in cows and buffaloes.

5.5.1.1 Milk production

Feeding nutritionally balanced rations play a vital role in realization of the genetic potential of dairy animals for milk production. A study conducted by NDDB in India indicates that the implementation of RBP under field conditions improved ($P<0.05$) daily milk yield by 2-14% and milk fat level by 0.2-15% in cows and buffaloes, while decreased ration cost by 5-11%. Average increase in net daily income of farmers has been reported by 6-60% per animal due to the increase in milk yield and milk fat level, as well as decrease in feeding cost (Garg *et al.* 2013).

5.5.1.2 Improving feed conversion efficiency

One of the most important parameters to ensure economic returns of dairy animals is the Feed Conversion Efficiency (FCE); a reflection of the efficiency with which nutrients from the diet are converted into milk. Opportunities to improve FCE are large in tropical countries like Nepal, where average productivity of dairy animals are very low and mostly fed imbalanced rations. Therefore, ration balancing provides a practical approach for improving FCE of low producing animals, with available feed resources in the region.

To evaluate the effect of RBP on FCE, NDDB conducted a study in cows (n=7090) and buffaloes (n=4534) under field conditions. Study shows that ration balancing has improved ($P<0.01$) FCE (kg fat corrected milk/ kg DMI) from 0.61 to 0.74, 0.79 to 0.90 and from 0.80 to 0.91 in indigenous cows, crossbred cows and buffaloes, respectively (Garg and Sherasia, 2015). Study indicated that through RBP, it is possible to increase FCE for milk production in cows and buffaloes to produce more milk per kg dry matter intake.

5.5.1.3 Microbial protein synthesis

Supply of adequate nutrients increases excretion of urinary purine derivatives, synthesis of rumen microbial protein and enhances the supply of protein post-ruminally to support the production. Various studies show that the balanced feeding improved ($P<0.05$) daily microbial nitrogen supply by 25.5 and 26.7% in cow and buffalo, respectively (Garg *et al.* 2014).

5.6 Indicative cost-benefit analysis of RBP

RBP will be implemented in module-wise. To cover 2.0 lakh animals, total 200 modules (50 module/year) will be implemented over a period of four years. One RBP module comprises 1 Technical Officer, under whom 10 Local Resource Persons (LRPs), having minimum 10+2 standards will provide ration balancing advisory services to 1000 milking animals in 50 villages.

FAO (2012) reported that through feeding balanced rations, average increases in net daily income of farmers ranged between Rs. 8 to 26 per animal per day. Through the ration balancing advisory services it has been possible to increase milk yield/fat and reduce the cost of milk production. On safer side, we have considered increase in net daily income Rs. 15 per animal. An indicative cost-benefit ratio of implementation of one RBP module is calculated (Table 24).

Table 24: Indicative cost-benefit analysis of one module of RBP

Sr. No.	Cost-Benefit	NR in lakhs
Expenditure		
1	**Capital** Tablet 11 x Rs. 15,000	1.65
2	**Consumable (Approx.)** RBP materials such as ear tagging, network charges, weighing balance, other accessories, and administrative cost	1.0
3	**Stipend** Technical officer 1 x Rs. 40,000/month LRP 10 x Rs. 3000/ month	5.1
4	**Training** Two week training will be provided to LRPs (one week class room and one week field)	1.0
	Total	**8.75**
Income		
1	Average annual increase in net daily income per animal, as a result of implementing RBP due to: i) Increase in daily milk yield with fat and; ii) Decrease in daily feeding cost (estimated @ Rs. 15/animal/day for 365 days for 1000 in-milk animals)	**54.75**
	Cost-benefit analysis	**6.25 times**

Chapter 6
Production and Distribution of Mineral Mixture

Most of the field animals suffer from mineral deficiencies at clinical and sub-clinical level. As a result, milk/wool production is low and the reproduction is severely affected. There is hardly any mineral mixture plant in the whole country. Very little quantity of mineral mixture is imported and sold at exorbitantly higher prices. It is proposed that four mineral mixture plants will be set in project districts for production and distribution of mineral mixture suitable for livestock, considering the agro-climatic and feeding conditions.

6.1 Introduction

Small and large ruminants require a number of dietary mineral elements for normal body maintenance, growth, production and reproduction. Minerals that are required in relatively large amounts are called major or macro elements. Those needed in small amounts are classified as micro, minor, or trace minerals. The major minerals include calcium, phosphorus, magnesium,

potassium, sodium, chlorine and sulphur. Among those needed in trace amounts are iron, zinc, manganese, copper, iodine, cobalt and selenium. Deficiency of minerals in the ration of animals impairs metabolic functions, which affects the growth in young calves and milk production and reproduction efficiency in adult animals. Supplementation of bio-available minerals through mineral mixture is of paramount importance, as minerals are nowhere synthesized in animal's body.

In Nepal, feeding of dairy animals is traditional in nature and much depends upon locally available feed resources. Crop residues based basal diet is poor in essential minerals. As animals do not synthesize minerals, their supplementation through mineral mixture is of paramount importance. Supplementation of minerals helps in efficient utilization of absorbed nutrients and many other ways, for improving growth, milk production and reproduction efficiency.

Mineral deficiencies in the ration of animals varies with agro-climatic conditions, mapping of such deficiencies are need to be undertaken across different zones under different States, to develop area specific mineral mixtures for supplementing the ration of animals in effective and economical manner (Garg*et al.* 2010). Based on survey work, mineral mixtures will be formulated for different states, incorporating deficient minerals and excluding excess minerals in the total ration of animals. Similar work on mineral status of dairy animals is being undertaken in India (Garg *et al.* 1999; 2000; 2002a; 2005; 2007; 2008; 2010; Ramana*et al.* 2001).

An International feed and feeding expertDr M R Garg assessing the mineral quality used in feeding dairy animals at a commercial dairy farm (Figure 17). Dr. Garg had also taken some photos of buffalo calf with rough hair coat, which clearly indicates deficiency of micro minerals in the ration (Figure 18).

Figure 17: International feed and feeding expert Dr M R Garg assessing the mineral quality used in feeding dairy animals at a commercial dairy farm

6.2 Functions of different minerals

Calcium (Ca):

- Essential for milk production.
- Necessary for bone & teeth formation.
- Required for contraction of muscles.

Phosphorus (P):

- Essential for milk production.
- Required in energy metabolism.
- Required for bone & teeth formation.

Magnesium (Mg):

- Important for the integrity of bone & teeth.
- Involved in protein synthesis and metabolism of carbohydrates & lipids.

Sulphur (S):

- Required for protein synthesis and metabolism of carbohydrates & lipids.
- Sulphur is a part of B-complex vitamins, thiamin & biotin.

Sodium (Na) & Potassium (K):

- Required for maintenance of osmotic balance.
- Required in acid- base equilibrium.

Copper (Cu):

- Required for haemoglobin synthesis.
- Necessary for tissue pigmentation & component of several metallo-enzymes.
- Required for normal reproduction functions.

Zinc (Zn):

- Spermatogenesis & the development of primary & secondary sex organs.
- Required for normal functioning of epithelial tissue.
- Activates vitamin A & its deficiency leads to night blindness.

Manganese (Mn):

- Co-factor for many enzymes involved in carbohydrate metabolism.
- Activator in the synthesis of fatty acids

Iodine (I):

- Required for the synthesis of thyroid hormone (T_3& T_4).
- Necessary for reproduction & growth of animals.

Cobalt (Co):

- Required for the synthesis of vitamin B_{12} by the rumen microbes.
- Essential for haemoglobin synthesis.

Figure 18: Buffalo calf with rough hair coat, indicating mineral deficiency

6.3 Production of good quality mineral mixture

Mineral mixture is manufactured using di-hydrate di-calcium phosphate (DCP) of rock phosphate origin and dried/monohydrate mineral salts. Dried/monohydrate mineral salts are crushed and mixed to a uniform particle size, using proper diluents, in a separate device, called ball mill. This trace mineral pre mix is taken in the ribbon mixer, along with DCP and few other mineral salts, for proper dispersion and uniform mixing. The resultant mineral mixture thus produced contains all mineral elements in desired proportion and stable form. Commonly used mineral salts along with % active element are given in **Annexure 15.**

6.4 Major equipment of mineral mixture plant

The mineral mixture plant can be designed in two sections. In first section, predetermined quantities of trace mineral salts are crushed into fine powder form in a ball mill of capacity 500 litres. In the second section, crushed mineral salts (trace elements) are thoroughly mixed with other ingredients viz. calcite powder, magnesium oxide, sodiumthiosulphate and di-calcium phosphate in a ribbon mixer and conveyed through screw conveyor to a storage silo.The mineral mixture plant consists of the following major equipment.

6.4.1 Ball mill

In the ball mill, pre-determined quantities of trace mineral salts are poured in the ball mill drum for grinding (Figure 19). The mixture is then crushed into fine powder form in minimum 1-1.5 hour time. The ball mill should be of 500 litres capacity and SS 304 rotating drum with minimum 60 kg of EN-31 balls of 50 mm diameter. Approx. 120 balls are required for crushing the granule to such an extent that 90 per cent of crushed powder should pass through 212 micron IS sieve. The crushed powder shall be collected in 50 kg bags manually.

Figure 19: Ball mill

6.4.2 Intake inclined screw conveyor

Di-calcium phosphate, magnesium oxide, calcite powder and sodium thio-sulphate along with the trace minerals pre-mix should be dumped into the hopper mounted on the conveyor to feed the ribbon mixer with the desired quantity.

6.4.3 Ribbon mixer

The ribbon mixer has a rated capacity of 500 kg. However, it is designed to handle maximum 700 kg, which is 40 per cent higher than the rated capacity. It has provision for forward and reverse rotation of the ribbon shaft for thorough mixing of various mineral salts and pre-mix, in maximum 30-minutes time. Raw materials are fed from the inlet at the top cover and after thorough mixing discharged from the bottom outlet, having a manually operated valve.

6.4.4 Silo inclined screw conveyor

The hopper of the conveyor receives the thoroughly mixed mineral mix powder from the ribbon mixer bottom outlet. The conveyor of 2.0 MT/hr capacity transfers the powder to storage silo.

6.4.5 Storage silo

The SS 304 storage silo of 700 kg capacity functions as an intermediate storage till the mixed mineral mixture powder is packed in 1/25/50 kg bags. The silo has a top inlet and a bottom outlet, provided with manually operated slide gate valve and motor operated bin discharge (Figure 20).

Figure 20: Ribbon mixer and silo

6.5 Mineral mixture formulation and mineral salts

Element	Requirement (%)	Mineral salt
Calcium	20.0 (Min.)	Dicalcium phosphate [Ca (%): 23.0 (Min.) P (%): 18.0 (Min.), F (%): 0.10 (Max.)]
Phosphorus	12.0 (Min.)	Dicalcium phosphate
Magnesium	5.0 (Min.)	Magnesium oxide [Mg (%): 52.0 (Min.)]
Sulphur	1.8-3.0	Sodium thio-sulphate [S (%): 39.0 (Min.)]
Copper	0.10 (Min.)	Copper sulphate [Cu (%): 24.0 (Min.)]
Zinc	0.80 (Min.)	Zinc sulphate [Zn (%): 33.0 (Min.)]
Manganese	0.12 (Min.)	Manganese sulphate [Mn (%): 31.0 (Min.)]
Iodine	0.026 (Min.)	Potassium iodide [I (%): 76.0 (Min.)]
Iron	0.40 (Min.)	Ferrous sulphate [Fe (%): 30.0 (Min.)]
Cobalt	0.012 (Min.)	Cobalt sulphate [Co (%): 20.0 (Min.)]

Directions for use

- **Milch cows and buffaloes:** 100-200g daily, depending upon level of milk production.
- **Growing and non-producing animals:** 50g daily per animal.
- **Young calves:** 20-25g daily for better weight gain or as advised by the Veterinarian / Nutritionist.

Mode of feeding mineral mixture

Mineral mixture can be fed by mixing it with concentrate mixture or by mixing 15-20 g common salt to it. Usually, compound cattle feed contains mineral mixture at varying levels, however, additional requirement can be met by mixing it with feed.

Benefits of feeding mineral mixture

- Improves growth rate of calves, hence early puberty.
- Improves reproduction efficiency in male and female animals.
- Reduces inter-calving period, more productive life of animals.
- Improves efficiency of feed utilization.
- Improves milk production.
- Better immune response; hence better resistance against infectious diseases.
- Calves born are healthy.
- Improves general health of animals.
- More economical and effective, if it is area specific.

6.5.1 Mineral mapping and production of Area Specific Mineral Mixtures (ASMM)

Minerals that are not sufficient from the feeds and fodder ingested by the animals only need to be supplemented through mineral mixture. Mineral mixture should supply only those minerals that are deficient in the ration. Mineral mapping programme in different parts of project areas need to be undertaken by testing feeds and fodder samples, so as to develop area specific mineral mixtures. Depending upon the level of minerals in feeds and fodder, area specific mineral mixture can be prepared for each state.

Calcium, phosphorus, magnesium, sulphur, sodium, potassium, copper, zinc, manganese, iron, cobalt, molybdenum and selenium.

Since higher level of molybdenum in feeds and fodders elevates the requirement of dietary copper, its dietary status will also be required to be assessed. Uptake of minerals from the soil by different fodders depends upon various factors such as type of soil, soil pH, irrigation, climate, application of fertilizer etc. Adequacy of minerals in soil may not always be the true indicator of adequacy/deficiency in fodder crops. In view of this, it is not required to analyze soil samples in various agro-climatic zones. Instead, quantitative intake of various minerals will be assessed, against the requirement, in various agro-climatic zones. On this basis, ASMM will be developed.

6.5.1.1 Methodology followed

From each of the agro-climatic zones in a State, two tothree districts will be identified. From each of the identified districts, all the taluka will be considered for collection of feeds and fodder samples. Based on the geographical distribution, one to two representative villages, preferably centrally located, will be identified from each taluka. From each village, four farmers will be selected for collection of representative samples of feed and fodder, from four different directions. Information regarding the number of animals, milk yield, actual feed intake, size of land holding, fodder crops being grown, will be collected from each farmer, in the prescribed pro-forma. All the feed samples thus collected, will be analysed for mineral contents.

Based on the body weight and level of milk production, mineral requirement of animals will be worked out. Adequacy and degree of deficiency of various mineral elements will assessed, based on actual intake and the requirements. According to the levels of deficiencies, area specific mineral mixture formulations will be developed, for different agro-climatic zones.

Since the agro-climatic conditions of terai region of Nepal aresomewhat similar to that of Bihar state of India, following area specific mineral mixture formulation could be referred to while formulating mineral mixture for terai region of Nepal, bordering Bihar (Table 25).

Table 25: Area specific mineral mixture formulation for the state of Bihar

Sr. No.	Characteristic	Requirement
1	Moisture (%), Max.	5.0
2	Calcium (%), Min.	20.0
3	Phosphorus (%), Min.	10.0
4	Magnesium (%), Min.	5.0
5	Sulphur (%)	4.0 – 5.0
6	Copper (%), Min.	0.10
7	Zinc (%), Min.	1.0
8	Cobalt (%), Min.	0.012
9	Iodine (%), Min.	0.026
10	Chromium (%), Min.	0.004
11	Fluorine (%), Max.	0.06
12	Acid insoluble ash (%), Max.	3.0
13	Lead (ppm), Max.	30
14	Arsenic (ppm), Max.	10
Note: The values for requirements (2) to (14) are on moisture-free basis		

6.6 Indicative cost-benefit analysis of feeding mineral mixture

Total four mineral mixture plants having 12 MTPD capacity of each will be set up. One mineral mixture plant will able to supplement about 1.2 lakhs animals (Dose @ 100 g/day/animal). Thus, total 4.8 lakh animals will be supplemented with mineral mixture (Table 26).

Table 26: Indicative cost-benefit analysis of feeding mineral mixture

Sr. No.	Cost-benefit	Unit	NR in lakhs
	Expenditure		
1	Cost of mineral mixture plant (Rs. 30 lakh/plant)	4	120
2	Miscellaneous (labor, packing, transportation etc.)		20
	Total		**140**
	Income		
1	Income from selling of mineral mixture Rs. 30/kg. • Production cost Rs. 70, Selling price Rs. 90 and Cost to the farmers Rs. 100/kg.	48000	14.4
2	Animals covered • Increase in lactation length @ 1month. (Considered effect on 50% animals). • Increase 90 litres milk/month (Ave. 3 lit milk/day).Cost of milk Rs. 40/litre.	480000	8640
	Total		**8654.4**
	Cost-benefit analysis		**61.8 times**

Chapter 7
Supplementation of Urea Molasses Mineral Block intheRation

Like other tropical and sub-tropical countries, bulk of basal ration of livestock in Nepal comes from crop residues, which are deficient in fermentable carbohydrates, nitrogen and minerals. As a result, feed intake is low and utilization of crop residues in the rumen is poor as rumen microbes don't get required nutrients for their growth from the basal ration. Since molasses are available in plenty in Nepal, especially in Terai region, it is suggested that four plants will be set up in Terai region of project districts for production of urea molasses mineral block (UMMB) lick. Each block could be of 3 kg that would last for about a week. Animals fed on crop residues based diets will be supplemented UMMB. By doing so, it should be possible to save concentrate used for feeding body maintenance. It will be specifically very useful for animals producing 2-5 litres milk per day, especially during lean periods when no green fodder is available during the lean period.

7.1 Introduction

The productivity of dairy animals in Nepal is greatly constrained by the lack of green fodder and good quality feed, due mainly to low availability and high cost. Crop residues and dry grasses are the major source of forages for feeding livestock in these countries. These crop residues are low in nitrogen and high in fibre and lignin; characteristics that restrict intake and digestibility in animals. Animal nutritionists, all over the world have proved that the nutritive value of these crop residues can be enhanced if supplemented with deficient nutrients (Makkar, 2002; Singh and Singh, 2003).

UMMB through licking provides fermentable nitrogen, energy and minerals intermittently, necessary for optimum microbial growth. Microbial protein can contribute 30–40 percent of crude protein requirement of an animal. As ruminants can produce microbial protein from non-protein nitrogen, UMMB supplementation in the ration is quite beneficial, especially when fed crop-residue based diets. The use of UMMB for supplementing crop-residue-based diets for livestock has the potential to increase livestock production and net daily income (Misra*et al.* 2006). UMMBs can be fed throughout the year but are more-beneficially utilised during the dry season or when the animals are grazing low-quality fodder.

7.2 UMMB production by *'cold process'*technology developed in India

In view of problems faced in manufacturing the block licks by the '*hot process*', efforts were made to produce blocks by the '*cold proces*s' using lime as a gelling agent. It was possible to produce reasonably-hard blocks using lime, however these blocks had very low palatability due to their bitter taste, resulting in poor acceptance at the field level.

Efforts were made to improve the block lick formulation, to ensure that the blocks were hard enough and also palatable to the animals. To achieve this, lime and magnesium oxide were used in combination, and a buffering agent was added towards the end of the process to reduce the pH which considerably improved palatability of the blocks. In addition to modifying the formulation and the production process, UMMB plant has been designed for manufacturing the blocks and a dispenser for feeding blocks (Figures 21,22 and 23).

Figure 21: UMMB plant developed by NDDB in India

Figure 22: Block licks after pressing

7.3 Advantages of feeding UMMB licks to animals

- Stimulates rumen fermentation, thereby, increases straw intake by animals.
- Increases microbial protein synthesis and supply at abomasum level, giving higher productivity.
- Improves daily milk (by 0.5–1.0 kg) and fat (by 0.3–0.5 percent) yields.
- Increases lactation length.
- Maintains health and reproductive functions.
- Improves growth rate of animals on straw-based diets.
- No risk of urea toxicity.

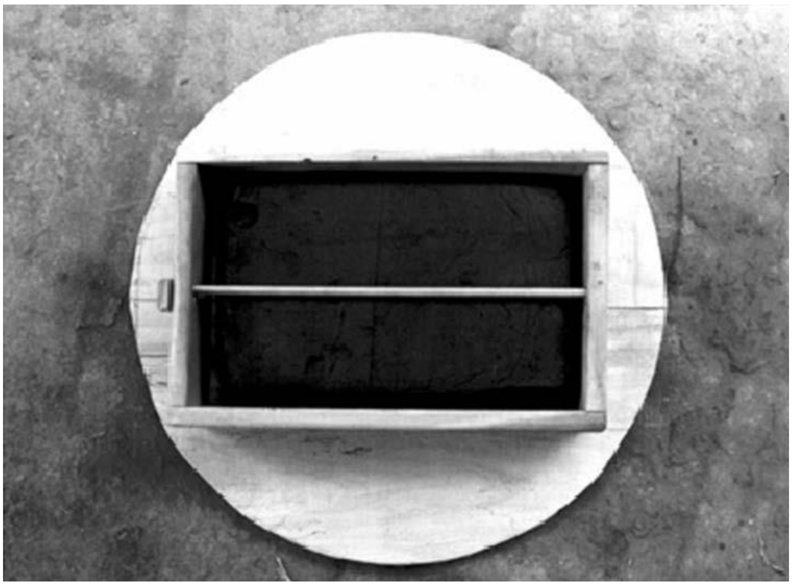


Figure 23: Wooden dispenser for UMMB licking

7.4 Effect of supplementing UMMB

7.4.1 Dry matter intake

When considering the dry matter intake (DMI) of fibrous feed, the primary limiting factors are its digestibility and the rate at which it is broken down to particle sizes that can pass through the reticuloomasal orifice. The fine grinding of fibrous feeds would facilitate its passage into the lower tract, but its digestibility in the lower tract is decreased. Hence it is ideal if the fibrous feeds are fermented in the rumen and broken down to particle sizes that can facilitate the flow and also facilitate its digestibility. Increase in intakes of dry matter, organic matter, crude protein, neutral-detergent fibre and acid detergent fibre with UMMB lick supplementation has also been supported by several researchers (Garg, 1989; Mohini, 1991). With UMMB supplementation, straw DMI increased by 30 to 50 percent in different experiments. Figure 24 shows the use of UMMB in large ruminant.

Figure 24: UMMB licking under field conditions in India and Nepal (Photo CR Upreti)

7.4.2 Digestibility and nutrient balances

Digestibility increased due to increased rates of rumen fermentation, mediated through a larger population of microflora and increased cellulolytic activity. Straw OM digestibility was around 40 to 45 percent under un-manipulated conditions. With UMMB supplementation, digestibility increased to 50 percent (Garg and Gupta, 1988). A noticeable effect of UMMB supplementation with wheat straw was that the negative N, Ca and P balances associated with feeding wheat straw alone became positive balances of 2.90, 2.85 and 0.50 for N, Ca and P, respectively, which indicated that the blocks provided compensatory nutrients for those that are limiting with wheat straw alone (Garg, 1989).

Mohini (1991) observed even significant enhancement in the digestibility of nitrogen-free extract (NFE) with UMMB lick supplementation in paddy-straw-based diets. Digestibility of ADF was enhanced from 37.4 percent to 41.3 percent with UMMB licks supplementation with wheat straw, while NDF digestibility increased much more than ADF, i.e. from 42.6 to 51.8 percent. DM and OM digestibility increased from 44.0 and 45.22 percent to 50.0 and 53.0 percent, respectively, by UMMB licks supplementation (Tiwari*et al.*1990). Based on these observations, it can be safely concluded that supplementation with UMMB licks boosted the digestibility of basal diets based on low quality forages.

7.4.3 Rumen fermentation

The important feature in utilization of nutrients in ruminants is the anaerobic fermentative digestion. Therefore, to increase the efficiency of nutrient utilization or productivity, there is need for actions that maintain an environment conducive to better microbial activity in the rumen. The major requirements for obtaining better microbial activity and cell production in the rumen are:

- Supply of enough nitrogen;
- Supply of enough ATP; and
- Supply of enough minerals and monomers.

The primary limiting factor with straws is N deficiency – insufficient N to ensure adequate ammonia in the rumen fluid. When supplementation in the form of UMMB lick was provided, the ammonia-N (NH3-N) in the rumen fluid increased to optimum. NH3-N concentration increased substantially from 76 mg/l to 239 mg/l after UMMB-lick supplementation with a paddy-straw-based diet. When NH3-N in the rumen increases, the lick consumption diminishes proportionally. The ammonia level is believed to be a bio-systemic control of lick intake by the animal. Garg (1989) observed significant ($P<0.01$) difference in rumen NH3-N level when wheat straw was supplemented with either concentrate mixture or UMMB lick. The NH3-N levels in rumen fluid were 223 mg/l and 183 mg/l, respectively, for UMMB lick or concentrate supplementation. Even at this high level of rumen NH3-N, blood NH3-N rose only to 1.27 mg/100 ml, which indicated no toxic effect of urea through UMMB licks.

Total N and trichloroacetic acid (TCA) precipitable N did not differ significantly between concentrate and UMMB lick supplementation. Equal TCAprecipitable N for both the supplements indicated equal microbial yields. When preformed amino acid sources increased in the UMMB block, the NH3-N content was not significantly different from the concentrate-supplemented group, which indicated that NH3 released from UMMB licks was used with the same efficiency as that from concentrate supplementation (Mohini, 1991).

With increased DMI, the volatile fatty acid (VFA) concentrations increased when lambs consumed UMMB supplement along with a basal diet of wheat straw. A small but insignificant shift in the VFA proportion towards higher propionate production was also observed. It was calculated that for 100 mg ammonia per litre of rumen liquor, the total VFA (TVFA) level should be around 25 mM/l. When UMMB was fed, the level of ammonia was 112–195 mg/l and TVFA concentration was 48–54 mM/l (Kunju, 1988). TVFA production was significantly higher ($p<0.01$) with concentrate supplementation than with UMMB supplementation with paddy-straw-based diets, compared with feeding paddy straw alone. Rumen turnover also increased with UMMB supplementation, which indicated rapid DM digestion due to effective colonization by the rumen microflora. Sixty percent of the straw DM disappearance was achieved in 48 hours by supplementing UMMB licks alone with straw based rations. Bacterial production rate as g/day DOMI was considerably higher with UMMB supplementation compared with concentrate supplementation. Nevertheless, the percentage efficiencies of N incorporation in cattle were 30.83 and 29.54 for concentrate and UMMB-supplemented groups, respectively (Garg, 1989).

In buffaloes, N incorporation efficiencies were only 23.31 and 17.78 percent for concentrate- and UMMB-supplemented groups, respectively (Mohini, 1991). In contrast, protozoan production rate was about halved in UMMB supplemented groups when compared with concentrate-supplemented groups. This could be due to a partial defaunating effect of either UMMB lick ingredients in general, or sodium bentonite in particular (Garg, 1989; Mohini, 1991).

The amino acid composition of ruminal bacteria showed higher serine, glycine, threonine, alanine and arginine, and lower lysine, while most of the amino acids were similar for protozoa, except for lysine, when animals were supplemented with either UMMB lick or concentrate mixture (Garg, 1989). The overall conclusion, based on rumen parameters, was that the UMMB licks could invariably and effectively replace concentrate supplementation at maintenance level.

7.4.4 Growth

Beames (1963) was the first to report that the provision of a salt-urea molasses block for cattle fed a hay-based ration significantly reduced loss in body weight. In sheep as well, the UMMB licks supplemented group lost less weight than the un-supplemented group (Coombe and Mulholland, 1983). Garg (1989) did not find significant differences in live weight gains when UMMB licks were used to replace up to 30 percent of total CP requirement previously obtained from concentrate mixture, and therefore affirmed that feeding practices can be made more economical by partially replacing concentrate mixture with UMMB licks.

Tiwari *et al.*(1990) attempted to determine the optimal proportion of fishmeal as a bypass protein source in support of UMMB licks that contained 38 parts molasses, 10 parts urea, 10 parts cement, 40 parts wheat bran, 1 part salt and 1 part mineral mixture (by weight). They provided fish meal at rates of 50, 100 and 150 g/day, and inferred that the calves provided with 100 g/day of fishmeal in addition to UMMB gained more weight than calves fed on UMMB alone or 50 g fishmeal + UMMB or 150 g fishmeal + UMMB. These liveweight gains were respectively 288, 90, 166, 179 and 275 g/day. When UMMB licks were prepared with 40% *subabul*(*Leucaenaleucocephala*) leaves, the weight gain was much lower than in the concentrate-supplemented group. The weight gains were 587 and 185 g/head/day respectively for the concentrate group and the subabul leaf-based UMMB licks group. In buffaloes, the weight gains were about 40 g/day higher than cattle (Mohini, 1991).

By using anti-pyrine as indicator, the body composition of the animals fed on concentrate or UMMB supplementation was studied in cattle (Garg, 1989) and in buffaloes (Mohini, 1991), and they observed no difference in body composition in cattle and buffalo calves after supplementation with UMMB licks. It could be concluded from these observations that UMMB licks can partly replace concentrate mixture and provide a fairly good growth rate in ruminants without any adverse effect on body composition.

7.4.5 Milk production

The effect of feeding UMMB lick on milk production was studied extensively at NDDB in India, both in buffaloes and crossbred cattle. Twenty Surti buffaloes in their second and third lactation were divided into four groups of five animals each. The first group was fed on rice straw and cattle feed. The second group received the same ration plus UMMB. The third group was given cattle feed equal to 80 percent of that given to first group, with UMMB lick. The fourth group was given cattle feed equal to 60 percent of the first group, along with UMMB and 1.0 kg bypass protein. It was observed that the economic gains in the fourth group were remarkable. The animals on an average licked 350, 570 and 370 g/day UMMB lick in the second, third and fourth groups, respectively. The fat-corrected milk yields were 7.38, 8.07, 6.99 and 7.19 kg over 120 days, respectively, for groups 1 to 4.

In lactating Jersey and crossbred Jersey cows, milk yields were tested by substituting 50 percent of green fodder with rice straw. Animals in group I were fed green fodder ad lib and concentrate at 40 percent of milk production. Animals in groups II and III were fed half the green fodder of group I, but with concentrate similar to group I. In addition, group II was offered rice straw ad lib, while group III was provided free choice of UMMB lick along with ad lib rice straw. Fat-corrected milk production was 10.45, 10.00 and 10.84 kg/day for groups I, II and III, respectively, with body weight changes of +0.187, - 0.245, +0.035 kg/day. Thus, the block lick supplementation could maintain milk production in both Jersey and their crosses in group III without loss of body weight with 50 percent reduction of green fodder DM and ad lib feeding of rice straw. It was noticed that the supplementation increased the net return over feed cost by Rs 2.42 per day per animal (1985 values).

Kunju (1988) reported on successful village trials with UMMB supplementation for milk production. It was observed under field conditions that each 3 kg block lick lasted for one week per animal. At six villages (situated in Kaira District Cooperative Milk Producers Union Ltd, Anand, Gujarat, India) the milk yields were enhanced in animals when given free access to UMMB licks. Not only milk yields, but also fat percentages were enhanced. Increased straw intake and fat yield were reported by most of the farmers. On average, each farmer benefited by Rs 2–3 per day. Many farmers reported improvement in the general health of animals on supplementation with block licks compared with feeding straw alone. Increased straw intake was reported by all farmers, with simultaneous improvement in milk yield and fat percentages.

7.4.6 Reproductive performance in Nepal

Shah (2018) conducted an experiment in the farmer's field around the vicinity of Livestock farm of Agriculture and Forestry University, Chitwan, Nepal. Thirty post-partum anoestrous buffaloes were selected and divided into two treatment T1 and T2. T1 group of animal having 10 numbers of buffaloes were fed with normal feeding (control) whereas T2 groups having 20 numbers of buffaloes were supplemented with UMMB along with normal feeding. Study indicated that out of 20 buffaloes in T2 group, 90% of animals came into oestrous as compared to control group (50%). Similarly, overall pregnancy rate was found to be 65% in T2 group as compared to T1 group (40%). Mean BCS (2.92) of buffaloes supplemented with UMMB was significantly ($p<0.05$) higher than the control group (2.65) at the end of the trial. BCS had significant ($p<0.05$) effect on the pregnancy rate. It is concluded that UMMB supplementation during dry summer season when green fodder is scarce helps in improving the body condition score and reproductive efficiency in buffaloes.

7.5 Indicative cost-benefit analysis of UMMB

Four UMMB plants (cap. 3 MTPD of each) will be set up at different strategic locations. Weight of each block will be about 3.0 kg; thus, total 4000 blocks will be produced per day under the NLSIP project. An indicative cost-benefit analysis for the production of UMMB is given in Table 27.

Table 27: Indicative cost-benefit analysis of UMMB

Sr. No.	Cost-benefit	Unit	NR in lakhs
Expenditure			
1	Cost of UMMB plant Rs. 25 lakh/plant	4	100
2	Miscellaneous (labor, packing, transportation etc.)		20
	Total		**120**
Income			
1	Income from selling of UMMB Rs. 10/block • Production cost Rs. 20/block • Cost to the farmers Rs. 30/kg. • Annual income from selling UMMB (40000 x 10 x 365)	4000	146
	Cost-benefit analysis		**1.22 times**

Chapter 8
Forage Processing andChaffing of Fodder

Fodders are processed to improvethe use and digestibility of forages for ruminantanimals

8.1 Chaffing of Fodder

In most of the filed animals, dry fodder offered is un-chaffed. According to scientific estimates, animals are wasting about 20% energy of the gross energy intake when fed un-chaffed fodder. In addition, cost of dry fodder is more than NRs 20 per kg, especially in hilly and mountain areas. About 25% fodder is wasted if fed un-chaffed. Thus, chaffing is proposed to be encouraged in the project areas by providing manual and motorized chaff cutters. This will minimize wastage and help improving the utilization of crop residues

8.2 What is chaffing

Making the folder stems or leaves into pieces by manual or mechanical means is known as chaffing. Cutting the roughage fodders in to small pieces manually with the help of axe/knife is called manual chaffing. Cutting of fodder by using machines are called mechanical chaffing, as shown in Figure 25. There are two types of chaff cutters available in the market:

1) Hand operated chaff cutter, and

2) Electrical chaff cutter.

For chaffing small quantities of fodder a hand operated chaff cutter is often used while for large quantities, an electrical operated chaff cutter can be used.

Figure 25: Chopping of fodder

8.3 Advantages of chaffing

1. The stems of grass can be made into pieces of any small size.
2. The leafy material and tender part of fodder shoot is eaten away by the animal and the thick or hard stem is left, which goes waste. By this chaffing whole plant or stems are fully consumed by the animal.

3. While eating in the manger the un-chaffed grass or fodder is wasted by throwing it in the surroundings by the animal. The chaffed pieces are completely eaten by the animal.
4. Chaffed material can be packed in bags.
5. The chaffed fodder consumes less space for storage.
6. Feed additives or other feed supplements can easily mixed with the chaffed fodder.
7. The leafy portion, shoots and stems pieces are mixed while chaffing, hence it increases the palatability of the fodder.
8. Energy waste in chewing can be minimized by offering chaffed fodder.
9. Digestibility, and thus milk production can be improved.

Generally, farmers are feeding green fodder without chaffing to their animals (Figure 26).

Figure 26: Farmers offering un-chaffed fodder in Nepal

Chapter 9.
Enrichment and Densification of Crop Residues

There is severe shortage of dry fodder in the hilly areas and mountains, whereas, dry fodder is wasted in the surplus areas, especially in terai region. It is proposed that two straw enrichment and densification plants will be set up for enrichment and densification of crop residues, especially paddy straw. Densified straw will be transported from surplus to deficit areas. This will reduce transportation cost, save storage space and help is judicious utilization of crop residues.

9.1 Introduction

Nutritive value of crop residues is low and these form the bulk of basal diet of ruminants in Nepal. Crop residues are not uniformly available across the country, some areas are surplus and there is a severe deficiency in some of the areas. The farmers move these crop residues in traditional way from surplus to deficit areas. Since bulk density of straws is very low, their transportation cost is high and storage space requirement is also more, if these are handled in loose form.

If crop residues are supplemented with low cost deficient nutrients and then densified, it is possible to save the transportation cost and storage space and at the same time nutritive value of straws can be improved for better growth and milk production. Different straws can be enriched and densified, depending up on their chemical composition and physical characteristics. After enrichment and densification, straws can be transported from surplus to deficit areas. Some of the technologies that have been standardized in India or elsewhere for handling different type of straws have been described here in brief.

9.2 Straw based pellets

Straws that are highly lignified with hard fiber can be easily crushed and are considered to be more suitable for production of straw based pellets. Wheat, soybean and mustard are some of the straws that can be used for production of straw based pelleted feed, using flat die. The feed formulation may contain 30-35% crushed straw, 10-12% molasses, 35-40% DORB, 10-15% protein meal, 1% urea, 1% common salt, 1.5% calcite powder and 1% mineral mixture. The production cost of these pellets could be in the range of Rs.3.00 to 3.50 per kg, when the availability of straws and other feed materials is in abundance. If these pellets are fed 6-8 kg per animal per day, it is possible to support body maintenance and 3-4 litres of milk. There are large number of such pellet mills available in India with spare capacity that can be used for production of straw based pelleted feed for the fodder deficit areas (Figure 27 and 28). It is possible to transport about 10-12 MT of such pellets in a truckload, shelf life more than a year. Cost of 30 MT per day straw pellet plant is about Rs. 40 lakh.

Figure 27: Machine for making straw based pellets

Figure 28: Straw based pellets

9.3 Enriched & densified straw bales

Straws that are having soft stem, with long stem can be chaffed to suitable length, sprinkled with deficient nutrients and can be baled with the mechanical device as shown in the Figure 12. Paddy straw is considered to be most suitable for production of this type of enriched bales. Bundles of paddy straw are cut in to 3-4 pieces and sprinkled with solution of molasses (10%), urea, minerals, common salt, 1% each, ensuring that the overall moisture does not exceed 15%. Enriched bales can be transported up to 6 MT in a truckload. This kind of enriched straw, if fed from 5-6 kg, can support body maintenance of adult animals. These bales can be stored for more than a year.

9.4 Straw based blocks

Figure 29: Densification machine

Feed blocks can be prepared from almost all types of crop residues after suitable processing (Figures 29 and 30). Block making unit comprises chopper, grinder, mixer and compactor and feed blocks of 5-25 kg can be manufactured, depending upon requirement. Formulation of block can vary, depending upon requirement. If blocks are required for meeting only maintenance requirement of animals, then the straw could be as high as 80% and concentrate ingredients up to 20%. However, if the feed blocks are required to produce for milk producing animals, then the straw component can vary from 30-50%, depending upon level of milk production. About 9-10MT of feed blocks can be transported in a truck and shelf life is more than one year, if the moisture content is kept below 11%. Approx. cost of block making plant of 15MT per day capacity is in the range of Indian Rs. 25-35 lakh.

Figure 30: Block making machine

Chapter 10
Compound Cattle Feed Quality Regulation

Legislation to monitor the quality of compound cattle feed in Nepal was drafted way back in 1976, that too only for two type of animals. And there are no specifications for mineral mixture. It is proposed that the legislation to monitor the quality of small and large ruminants is re-drafted, covering specifications for all categories of animals, with latest test methods and a maximum permissible limit of Aflatoxin B1. Feed testing laboratories would be recommended for renovation, to be used for monitoring quality of raw materials and finished feed.

10.1 Introduction

Since dairy animals in Nepal have limited access to cultivated green fodder and grasses, compound cattle feed becomes an important constituent of dairy ration. Quality of cattle feed has a direct impact on milk production, reproduction and fertility of dairy animals, and thus profitability of dairy farmers. For profitable dairy farming, quality of cattle feed is of paramount important because most of the macro and micro nutrients are being provided by cattle feed to meet the nutrient requirement of dairy animals.

Production of quality cattle feed ensures the food safety, reduce the cost of milk production, maintain or increase milk quality and consistency, and enhance animal health and welfare by providing adequate nutrition at every stage of lactation. Quality of cattle feed is also important from food safety point of view, as most of the contaminants, pesticide and drug residues etc. are transferred from feed to milk, causing health hazards to the human population.

10.2 Quality control

Quality control is everyone's responsibility; it must be built in at every stage of the plant process, from identifying the customer's needs, through planning and implementation right up to the point of receiving raw materials to the delivery of finished products. It also needs to be checked even beyond delivery to the customer.

Quality control (QC) in cattle feed production is most importance for overall success and profitability of dairy industry. The main objective of QC is to ensure that a consumer should obtain feeds that are unadulterated, true to their nature and produce desired results. Quality control is therefore, defined as the maintenance of quality at levels and tolerances acceptable to the buyer while minimizing the cost of processing. There is a strong relationship between the quality of cattle feed and animal performance and thus, the challenge for animal nutritionists and production managers is to consistently monitor all aspects of the feed production system being used and measure those variables that are good indicators of QC. A robust QC system provides the mechanism to ensure that all quality criteria are met and provides a system to constantly monitor the cattle feed plant operations along with laboratory analysis results and identify opportunities for further improvement (Garg *et al.* 2013).

10.3 Feed regulations in developed countries

10.3.1 Feed regulation in United States of America

The use of food products in USA is governed by the provisions of the Federal Food, Drug, and Cosmetic Act (FFDCA), and the regulations issued under its authority. These regulations are published in the Code of Federal Regulations (CFR). The FFDCA defines food as *"articles used for food or drink for man or other animals"* (FDA, 2018). Therefore, any article that is intended to be used as an animal feed ingredient, to become part of an ingredient or feed, or added to an animal's drinking water is considered a *"food"* and thus, is subject to regulation. FDA’s Centre for Veterinary Medicine is responsible for the regulation of animal food (feed) products.

10.3.2 Feed regulation in European Union

In 2002, the European Parliament and the Council adopted regulation (EC) No 178/2002 laying down the general principles and requirements of food law called General Food Law Regulation (EC, 2002). The General Food Law Regulation is the foundation of food and feed law. It sets outs an overarching and coherent framework for the development of food and feed legislation both at union and national levels. It also sets up an independent agency responsible for scientific advice and support, the European Food Safety Authority (EFSA). The authority provides scientific advice and technical support for the community's legislation and policies in all fields which have a direct or indirect impact on food and feed safety. Legislation on animal feed is harmonised at EU level.

10.3.3 Feed regulation in Australia, New Zealand and England

In Australia and New Zealand, Food and Animal Feeds are regulated by the Ministry of Primary Industries (Legislation Act 2003) under the Australia New Zealand Food Standards Code (FSANZ, 2017). Food Standards Agency (FSA) is the main body of Feed and Food Safety Law at central level in England, Wales and Northern Ireland (FSA, 2016). Thus, internationally the quality of food and feed are regulated under a common Act by an independent authority.

10.4 Feed regulation in Nepal

In absence of strict regulatory mechanism in Nepal, many manufacturers of cattle feed resort to the use of harmful ingredients such as rice husk, and low priced raw material such as calcite powder to make low priced cattle feed. Problems such as low milk yield of dairy cattle and sub-optimal fertility can be attributed in a large measure to the lack of adequate quality in compound cattle feed. Therefore, there is an urgent need to revise the existing Feed Act (1976) to regulate the manufacture and sale of cattle feed.

Chapter 11
Green Fodder Production and Enhancement

11.1 Green Fodder Production

Green fodder is the most economical source of nutrients, as compared to the expensive imported concentrate feeds. I will be ensured that the green fodder production in the project area is enhanced by increasing the use of truthfully labelled/certified fodder seeds, wherever applicable, by promoting their production and marketing. Similarly, suitable measures will be proposed and implemented for enhancing fodder from trees, pastures, silvi-pastures, grazing land etc. Surplus green fodder would be conserved in the form of hay and silage.

Green fodder plays a major role in feeding of dairy animals,thereby providing required nutrients for health, productive andreproductive efficiencies of dairy animals. Green fodder is animportant and economic source of nutrients and provides betteroption for costlier concentrate feed ingredients. It is highlypalatable and digestible (Mohini*et al.* 2007). Increased use ofgreen fodder in the ration of animals reduces cost of milkproduction. Prusti*et al.* (2014) reported that enteric methaneemission was reduced by 5-12% on feeding green fodder basedration to river buffaloes. Dairy animals producing up to 5-7 litresmilk per day can be maintained exclusively by feeding greenfodders.Inclusion of green fodders in the ration of dairy animaldecreases amount of concentrate feeding and thus increasesprofit. Therefore, for economic and environmental sustainabledairy production, fodder production round the year is highlyessential.

11.2 Ways to increase green fodder production

- Use quality seeds of high yielding varieties/hybrids of fodder crops.
- Follow recommended agronomical practices of cultivation.
- Follow suitable crop rotation.
- Select short duration fodder crops (sunflower/mustard/turnip) during the switch-over season.
- Sow legume as an inter-crop or as a mixed crop with a non-legume crop to enhance the nutritional value of fodder and improve soil fertility.
- Plant perennial grasses like hybrid napierbajra/guinea grass in about 15 to 20 per cent of the cultivated area to get green fodder round the year.
- Plant fodder trees/shrubs on farm boundaries to get green fodder during the lean period.
- Harvest fodder at the appropriate stage to get the maximum nutrients.
- Adopt modern practices for hay and silage making to ensure supply of fodder during scarcity and avoid wastage of surplus green fodder.
- Use chaff-cutter to minimise wastage of fodder.

Following fodder crops/grasses/trees are available in different agro-ecological zones of Nepal:

Annual

- **Legumes**: Berseem, Lucerne, Cowpea, Guar, Rice bean, Velvet bean
- **Cereals**: Sorghum, Oats, Maize, Millets, Barley
- **Miscellaneous**: Mustard (Chinese cabbage), Turnip, Fodder beet, Soya bean, Sunflower

Perennial

- **Grasses**: Hybrid napierbajra, Guinea grass, Para grass, Congo signal grass
- **Range Grasses**: Nandi grass, Anjan grass, Blue panic grass, Marvel grass, Rhodes grass

- **Pasture legumes**: Butterfly pea, Stylo, Siratro
- **Shrubs & trees**: Hedge lucerne, Subabool, Siris, Khejari, Shevari, Gliricidia.

11.3 Important verities ofmajor fodder crops and their estimated production

Sorghum (*Sorghum bicolor*)

It is the most important cereal fodder crop grown in summer/rainy season. Covering the maximum cultivated area among fodder crops, sorghum is grown in all parts of the country except the cool hilly areas. It has high tolerance to drought and excessive rainfall. There are single, two and multi-cut varieties/hybrids of sorghum giving one to six cuts per crop producing 50 to 100 tonnes/hectare of green fodder. To avoid prussic acid or cyanide toxicity to livestock, the crop should be harvested at about 50 per cent flowering or after irrigation at the pre-flowering stage. The crop is also useful for hay and silage making.

Important varieties: PC-1, PC-6, PC-9, PC-23, HC-136, HC-171, PSC-1, Pant Chari-5, Pant Chari-6 and Sorghum sudan hybrid.

Berseem (*Trifoliumalexandrinum*)

It is a legume crop of the winter season. It gives six to seven cuts between November to May and produces 70 to 80 tonnes/hectare of extremely palatable and nutritious green fodder containing about 20 per cent crude protein. Berseem fodder is known as the 'milk multiplier'. Being a leguminous crop it also fixes atmospheric nitrogen in the soil and improves soil fertility.

Important varieties: JB-1, BL-1, BL-10, BL-42, UPB-110, Mescavi and Wardhan.

Lucerne (*Medicagosativa*)

Known as the 'queen of fodder', lucerne is the most popular fodder crop after berseem and sorghum. The crop can give seven to eight cuts from November to June with an average green fodder yield of 60 to 80 tonnes/hectare. The fodder contains about 20 per cent crude protein. The crop is appropriate for hay making. In some areas, it is cultivated as a perennial crop.

Important varieties: T-9, A-2, A-3, RL-88, CO-1 and LLC-5.

Cowpea (*Vignaunguiculata*)

This legume crop is grown under both irrigated and rainfed conditions. It is widely cultivated across the country excluding the temperate hilly areas. It has great potential as a mixed crop when sown with maize, sorghum and millets to produce an ideal 'legume & cereal' fodder mixture. It grows quickly and can yield 25 to 45 tonnes/hectare of green fodder. It also finds use as green manure.

Important varieties: EC-4216, UPC-287, UPC-5286, GFC-1, GFC-2 & GFC-4.

Oats (*Avenasativa*)

It is a winter season cereal fodder crop. It has excellent growth and shows quick regeneration capacity after cutting. The green fodder is succulent, rich in carbohydrates and palatable. The yield ranges from 30 to 50 tonnes/hectare. The crop can also be used to prepare hay and silage.

Important varieties: Kent, UPO-94, UPO-212, OS-6, OS-7, OL-9, JHO-822, JHO-851 and HFO-114.

Maize (*Zea mays*)

Maize is one of the best cereal fodder crops grown during summer, rainy and/or early winter season. It produces rich and nutritious green fodder which is a good source of carbohydrates. The green fodder is particularly suitable for silage making. The yield varies from 30 to 40 tonnes/hectare.

Important varieties: African tall, JS-1006 and Vijay composite.

Crop rotation

Suitable rotation of crops not only enhances the productivity of land but also ensures availability of green fodder round the year. An indicative list of some crop rotations is given below Table 28.

Table 28: An indicative list of some crop rotations

Sr. No.	Crop rotations	Green fodder production potential (tonnes/hectare/year)
1	Hybrid napierbajra + Cowpea – Berseem + Mustard	285
2	Maize + Cowpea – Maize – Cowpea – Oats – Maize + Cowpea	165
3	Maize + Cowpea – Rice bean – Berseem + Mustard	110
4	Hybrid napierbajra + Guar – Lucerne	250
5	Sorghum + Cowpea – Maize + Cowpea – Maize + Cowpea	110
6	M.P chari – Cowpea – Berseem + Mustard – Sorghum + Cowpea	168

11.4 Fodder Conservation

Aims of fodder conservation

With the availability of high fodder yielding varieties of seasonal/perennial fodder crops, there is glut of fodder during the peak periods of growth and scarcity during other periods. The best way to regulate the supply of palatable and nutritive fodder during the lean periods of October and November and May to July is to conserve the surplus fodder in the form of hay and silage. A similar situation is also experience in the case of grassland species which essentially comprise the monsoon grasses. These grasses give abundant fodder during the monsoon period and in summer season, the forage production is almost negligible owing to their dormancy with the advent of winter and acute moisture stress. Thus it is essential that surplus fodder should be conserved during the period of excess growth, in the form of hay and silage. The need for the conservation of fodder is all the more warranted in the drought - prone areas, where crop failures are frequent.

11.4.1 Silage Making

Silage is the conserved green fodder having moisture content in the range of 65 to 70 per cent. Fodder crops rich in soluble carbohydrates are incubated after chaffing for 45-50 days under anaerobic conditions. Sugars present in the fodder are converted to lactic acid, which acts as a preservative and a good source of readily fermentable sugars for the rumen microbes. Under proper storage condition, silage can be stored even up to two years. Good quality silage should not have any butyric acid, which gives off flavour to silage. If proper anaerobic conditions are not maintained, silage produced would have butyric acid content in it.

Crops suitable for silage making

The fodder crops, such as maize, sorghum, oats, pearl millet, and hybrid napier rich in soluble carbohydrates are most suitable for fodder ensiling. Quality of silage can be improved with the use of suitable additives such as molasses, urea, salt, formic acid etc.

Infrastructure required for silage making

1. Silo – Surface or trench.
2. Farm machinery like tractor, trailer, fodder harvester & power chaff cutter.

To construct the surface silo for large farmers/community silage making, estimated investment would be about Indian Rs. 12.00 lakh to preserve about 100 MT of green fodder. The cost of fodder harvester/chopper would be Indian Rs. 1.50 lakh approximately.

For medium class farmers 5-7 MT surface silos (manually pressed) would cost around IndianRs. 25000 and another Indian Rs. 25000 for the chaff cutter.

Procedure of silage making

- Construct a surface/trench silo (silage storage structure). One cubic meter space / silo can store 500-600 kg of green fodder.
- Harvest the crop at 30-35 per cent dry matter (DM) stage.
- Wilt the harvested fodder to bring down DM to 30-35 per cent, if required.
- Chop the fodder into small pieces of 2-3 cm size.
- Fill the chopped fodder into the silo.
- Press the chopped fodder in the silo layer by layer of 30-45 cm.
- Filling and pressing should be completed as fast as possible.
- Use additives during filling of fodder in the silo, if required.
- After filling and pressing, seal the silo with thick polyethylene sheet.
- Put weight through mud layer/ sand bags/ tyres on the sheet to prevent air flow beneath the sheet.
- Open the silo for feeding, minimum after 45 days, as per need.

Feeding of silage

- Silo can be opened from one side as per need after 45 days and closed properly after taking out the silage.
- Silage can be taken out as per requirement. Initially, silage can be fed @ 5 kg/animal to adjust the animals on silage feeding.
- Silage is a substitute of green fodder and can be fed like green fodder.

Characteristics of good quality silage

- Bright, light green yellow or green brown in colour.
- Lactic acid odour with no butyric acid and ammonia odour.
- Firm texture with softer material.
- Moisture should be in range of 65-70 per cent.
- Lactic acid 3-14 per cent.
- Butyric acid less than 0.2 per cent.
- pH in the range of 4.0-4.2.

Critical factors affecting production of good quality silage

1. Type of Silo – Surface silo are best due to ease of ensiling.
2. Dry Matter of fodder – Ideal 30-35 per cent.
3. Chop length of fodder – Ideal 2-3 cm, easy to get compacted.
4. Pressing/compaction of fodder – As quick as possible to minimise aerobicfermentation.
5. Sealing of silo – To check inflow of air and water into silo.

Figures31, 32 and 33 shows the image of silo pits.

Figure 31: Surface silo

Figure 32: Covered surface silo

Advantageof silage making

- Ensures regular supply of fodder to the dairy animals.
- Ensures uniform quality fodder to animals during different seasons.
- Silage can be made under almost all weather conditions.
- Surplus green fodder can be conserved, minimising wastage.
- Feeding silage is an effective tool for the control of parasitic diseases, as the parasites present in different stages in green fodder are destroyed during ensiling.
- Enhances green fodder productivity by improving harvesting intensity.
- Enhances livestock productivity by ensuring fodder supply, especially during the lean period.

Figure 33: Pressing fodder in a silo

11.4.2 Hay Making

Hay refers to grasses or legumes that are harvested, dried and stored 85-90 percent dry matter. When harvested in the proper physiological stage of growth and well cured to 20 percent or less moisture at the time of storing, hay can be utilized as an excellent feed for dairy animals, particularly when fodder is scare or pasturage is insufficient. Hay contains more nutrients compared to poor quality of straws, as it is prepared before harvesting. So nutrients which goes to grains and seeds are retained. In Nepal during monsoon, there is lot of scope far growing of excess of fodder crops. These excess fodder crops can be cut and made into hay which retains most of the nutrients of green grass and can be fed during lean season.

During the time of harvesting, there is sudden interruption of thetransportation stream. The shutting off the water supply from the roots and acontinued evaporation from the leaf surface leads to drying and death.However the plant's respiratory enzymes activity willcontinue, resulting in the oxidation of some valuable plant nutrients. Following biochemical changes will occur while making and storage of hay at ambient temperature.

- Soluble carbohydrates which are highly digestible will be oxidized causingloss of dry matter.
- Total soluble nitrogen of amino acids as opposed toprotein nitrogen increases as a result of proteases.
- Cyanogenic glycosidesofjowar, white cloves and few other forages have been shown to lose theirtoxicity property during drying which may be due to denaturation of the enzymesresponsible for liberation of hydrocyanic acid.
- Rapid drying of hay tends toprotect the carotene content due to quick inactivation of the concerned enzymes.
- The exposure of ultraviolet rays of sun converts ergosterol into ergocalciferol(Vitamin D2) in plants thus the process of hay making by sun drying increasesthe value of Vitamin D.
- Hay stored may undergo some fermentation whichgives silage type of flavour.

Good quality hay is better than very mature green crops. Nutritive properties of hays are almost similar to those of forages. Maintenance requirement for all classes of animals can be met by feeding only hay. Up to 5 litres of milk production, hay can be fed without any concentrates. Hay is excellent source of cellulose, sufficient ruminant termination, and increase butter fat production.

Selection and harvesting of crops for hay making

Preparation of hay by sun curing depends on the type of crop available and the climatic conditions. Thick stemmed crops like maize and jowar are not suitable for hay making as it will take longer time for the stems to dry. Thin stemmed crops like lucerne, oats and grasses are suitable for hay making. The stage of maturity of the crop at the time of cutting is very important as far as nutritive value of the hay is concerned. An early cut means more nutritive value but less yield. Late cutting on the other hand will result in less nutritive value but more bulk. Legume hays are made out of leguminuous plants like lucerne and other clovers. They are rich in proteins, vitamins and minerals. The non-leguminous hay contain less proteins, minerals and vitamins. These hay may be from grass.

Hay making

The fodder crop is cut when $2/3^{rd}$ of the entire crop is in flowering stage. The cutting should be done in cool hours of the morning arid protected grass from sun rays. It is put in small heaps in shade, so that it is easy to take turning process - it is than stacked on an elevated ground. The heaps of the hay is put to a height of 7 to 9 meters. Around the heap a channel of 20 cm deep and 30 cm wide is provided to drain the rainwater. The hay can also be stocked in a well-ventilated shed.

Characteristics of good quality hay

1. Hay must be leafy. Green to brown in colour.
2. It should heavy soft and pliable stems.
3. It should be free from moulds, weeds and dust.
4. It should be palatable and have pleasant smell and aroma.
5. It should not contain more than 20% moisture.

Advantage of hay making

- Hay is less expensive to prepare.
- More quantity can be stocked on less space.
- It is nutritious compared to straw.
- It is palatable and animal eats it greedily.

11.5 Rangeland productivity and plan under the project area

11.5.1 Rangeland distribution and productivity

Based on the land use pattern, Nepal's total rangelands are about 1.75 million hectare out of which about 80 percent of total range land is in high hills and mountain. Out of the total rangelandonly 37 percent of rangeland is available for livestock.

Mountain occupies about 63.6 %, hills 4.4 and Terai 32 percent of the total rangeland available in Nepal (LRMP, 1986). This has indicated that the need of rangeland management in the mountain project districts such as Mustang, Manag, Ilam, Panchthar, Dhankutta, Kaski). Some local pasture crops in rangeland considering the altitude has been shown in Table 29.

Table 29: Range in some selected project districts (Mustang and Manag)

Altitude	Mustang	Manag (including lower belt)
40000-50000	1.Karagana, 2.Khampa 3.Gamber 4.Buki	1.Karagana, 2.Khampa, 3.Gamber 4.Tangar, 5.Buki, 6.Pang
3000-4000	1. Panchi, 2.Sunbuki 3.Kok Doma, 4.Charamba, 5.Krtlang	1.Buki, 2.Dolo Kane, 3.White clover 4. Numril, 5.Marmindo, 6.Kanbuchi
2000-3000	1.Kote, 2.Banso, 3.Ratnaulo, 4..Dhimja	1. Pang, 2.Banso,Ratnaulo, 3.Buki, 4.White clover 5. Halhale

NARC 2001/2, Anual Report ARS (Pasture), Cited by Khanal, 2011.

11.5.2 Carrying capacity of rangeland in the project districts

The carrying capacity of the rangeland is different and location specific (Table 30).

Table 30:Carrying capacity of rangeland in the project districts (selected districts)

Project/nearby districts	DM/hac (ton)	Carrying	Stocking density
1.Panchthar	0.99	1.66	16.3
2.Ilam	1.00	1.70	14.5
2.Mustan	1.0	1.60	26.0
3.Manag	0.90	1.2	14.0

Source: NARC/ARS Rasuwa 2066 BS. Cited by Khanal, 2011.

The carrying capacity of the rangeland in project districts can be affected by several factors as shown in Table 31.

Table 31: Factor affecting on rangeland productivity and stocking rate

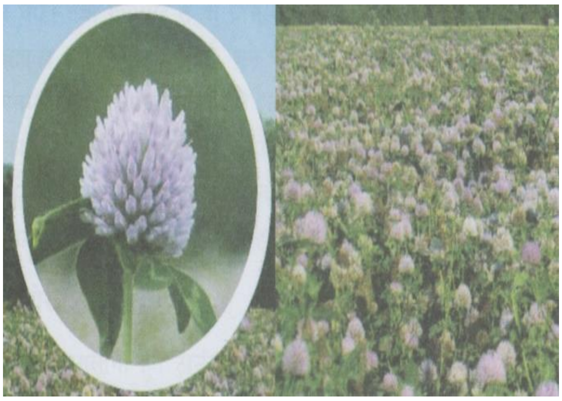
1.Factor affecting productivity of rangeland	2. Factor affecting stocking rate
1.Stage of growth of grass	1.Rate of forage growth
2. Soil factor	2.Season (winter, summer)
3.Climatic condition	3.Use of fertilizer
4. Pattern of utilization of rangeland	4.Nutritive value of herbage
5. Fodder species	5.Plalatibility of the grasses
6.Managemeny	6.Availability of grass
7. Disease and pest	7.Type of grazing animal.

Source Khanal, 2011.

11.5.3 Rangeland forage crop and their productivity

There aremore than 50 forage species suitable for the rangeland use but only suitable to NLSIP project districts are discussed in this report. These fodder species can be multiply in Government farm for seed multiplication for further distribution to the participating farmers in the range land of NLSIP project districts. These fodder species are tasted in Government research station and recorded for their productivity in different agro ecological zone of the country.Some range forage has been shown in figure 34.

Rye grass (cereal crop) in Manag



White clover (Leguminous crop) in Ilam

Figure 34:Top ranking rang forage crop and medicinal plant for rangeland development in NLSIP hills and mountain

Lucern: Well established Mustang

Netle: Medicinal herb at rangeland

Figure 35: Concentrate feeding while milking chauri in rangeland at Pacjthar (Taplejung Boarder)

A field assessment on pasture in trans–Himalayan districts has shown the potential to develop the pasture for Chyangra and bhyanglung sheep including the yak, chauri and horses (Table32). This observation provides the existing situation of pasture crop and need of further intervention to improve the rangeland by using NLSIP fund.

Table 32: Practical interventions for forage development in the NLSIP districts (Manang and Mustan)

Farmers' view	Expert view	Feed quality	Recommended for scaling up	Expert view	Recommendations
1. Manag					
Commercial and subsistence farmers have interest on pasture grass and fodder trees	Promotion of red clover, tall fescue, rye grass, white clover, Lucerne. Top priority to be given for promotion of local forages, herbages	CP in legume species-15-20%, non-legume species-6-16%	Ascertain; -Availability of seeds, saplings -Transplantation and harvesting technology -Feed conservation methods	-Improve on; -feeding system -Extension -Trainings, interaction, visits, demonstration, forage trading	Promotion of forage in small plots- -Develop irrigation facility -Close coordination with nature conservationists, local authorities -Protect eroded land with fodder tree transplantation
2.Mustang					
Commercial and subsistence farmers have interest on pasture grass and fodder trees	Promotion of red clover, tall fescue, rye grass, white clover, Lucerne. Top priority to be given for promotion of local forages, herbages	CP in legume species-15-20%, non-legume species-6-16%	-Ascertain availability of seeds, saplings -Transplantation and harvesting technology -Feed conservation methods	-Well-managed farming system -Extension education -Trainings, interaction, visits, demonstration, forage trading	-Promotion of forage in small plots- -Develop irrigation facility -Close coordination with nature conservationists, local authorities -Protect eroded land with fodder tree transplantation -Climate smart farming -Protect national heritage -Protect precious animal genetic resources

Source: K.P.Poudel 2018.

11.5.4 Range fodder crops at NLSIP project districts

There are well adapted rangeland fodder species in project district .It is well presented in Table 33 with cultivation practices and productivity.

Table 33: Range forage cultivation practices biomass production and seed production (well adapted in Nepal)

Range pasture species	Verities	Sowing seasons (Months)	Seed rate (kg/h)	Fodder production (Ton GM/h)	Seed production Kg/h)
1.White clover (*Trifolium repens*)	Ladino, Haifa, Rigal,Yilman, Arkadiya	Chaitra-Baishakha (April-May)	4-5	12-15	400-500
2.Perenial Ryegrass (*Lolium perenne*)	Ranue, Peramo, Lamora	Baishag (May)	10-15	40-60	500-600
3.Cocksfoot (*Dactylis glomerata*)	-	Jestha-Ashad (June-July_	10.00	50-60	-
4.Timothy (*Phleun pretense*)	-	Jestha-Ashad (June-July_	10.00	15-20	-
5. Kote (*Medicago falcate*)	-	Jestha-Ashad (June-July	12-15	0.4-0.5	-
6.Setaria (*Setariea anceps*)	-	Jestha-Ashad (June-July	4.00	75-150	-

Range pasture species	Verities	Sowing seasons (Months)	Seed rate (kg/h)	Fodder production (Ton GM/h)	Seed production Kg/h)
7.Tall fescue (*Festuca arundinacea*)	-	Chaitra (April)	10-12	40-50	-
8. Siratro (*Maroptilium atropurpureum*)	-	Jestha-Ashad (June-July)	2-8	15-25	-
9.Stylo (*Stylosanthes spp*)	*Stylosanthes hamata, Stylosanthes guinensis*	Jestha-Ashad (June-July)	4-5	50-60	200-300
10.Rhodes (*Chloris gayana*)	-	Baishag (May)	8-10	0.450-0.600	-
11.Paspalum (*Paspalum dilatatum*)	-	Jestha-Ashad (June-July	10.0	20-30	-
12. Kudju (*Pueraria thumbergiana)*	??	??	15-25	20-25	??
13.Centro (*Centrosema pubescens*)	?	?	3-5	4050	?
14.Desmodium	?	?	30-35	3-5	?

Source: NARC (ARS Rasuwa)2011 Pp 85-96.

11.5.5 Rangeland Management

Field survey at Ilam and literature review has indicated that the pasture management system is still traditional. Yak and Chauri herder are not adapting any scientific technique to develop and conserve the rangeland. However, Northern-belt Pasture Development Program was launched in 10 high-altitude districts in 1983, which terminated in 1992 with very limited achievement.Forage Mission 2070/71was executed in different 40 districts in three phase as shown in Table 31and 28 districts included the NLSIP project districts.

11.5.6 Government policy of the rangeland management

After the NRPDP, Government of Nepal initiated “Forage Mission Program 2070” and implemented in 40 districts across the country (Table 34).

Table 34: Animal feed Development National Mission operation directives 2070 (Programdistricts)

Fiscal Year	Number of districts
1.First Phase: 2070/71	25
2.Second phase 2071/72	10
3.Third phase 2072/73	5
Total districts	40

Note: All districts of forage mission is under NLSIP districts.

11.5.7 Rangeland improvement technology for hills and mountain

With the practical experience in Nepal, following 10 technologies can be recommended for rangeland development in the NLSIP project districts (Ilam, Manag and Mustang and other highland districts.) to support the Chyangra, Bhyanglung sheep, Yak and Churi. Technique to develop the rangeland to support the high mountain ruminant animal (Chyangra, Yak and Chauri) is described in Table 35.Guideline will cover the detail of rangeland management.

Table 35:Rangeland development technique (10 Points)

SN	Rangeland development technique	Significance
1	Use of improved pasture species	Increases the fodder yield
2	Provision of drinking water in the rangeland:	For irrigation and drinking
3	Opening of Range track	Excess to unused difficult land
4	Removal of unwanted bushes	Clears the weed and toxic plants
5	Opening of unused pastureland	Opens the rangeland to support animal
6	Improve the fertility of pastureland (use of FYM)	Productivity of rangeland increases
7	Provision of irrigation	Support to increase crop yield
8	Rotational and control grazing	Protect the species from over grazing
9	Use of climate change adaptive technology: fodder	Fodder crop supplies continuous feed.
10	Adapt the Rangeland policy 2068	Regulate the rules on pasture land

Source: NARC/ARS (Pasture) Rasuwa, 2011 Pp 1-118.

Case Study on Rangeland management in Sirke Kharka Ilam (Field survey)

Mr. Raj Kumar Rai and his wife Ms. Kanchi at Sikre of Falelun near Santapur owned total 30 adult chauri with followers have 25 hectare of land near by water source (2 km). The pasture land is unimproved but ownerknow the importance of rangeland management as he is involved with red panda program as social mobilize. He is facing the feed shortage during winter but the range is potential to develop as rangeland for yak and chauri. He is selling Churpi @ Nrs 800 to 1000/kg. And raw ghee @ 500-600/kg. Rangeland is being over used, and Chairperson of Falelung Rural Municipality is forcing to remove Chauri from the rangeland. Chauri farming is the livelihood of the local people. They are demanding program of rangeland management. Following suggestion was made by expert during the recent field visit and group of farmers (15 farmers) are interested to participate in rangeland improvement.

(1) **Rangeland Improvement:** Remove bushes and poisonous plant (2) Remove stones of upper part of the rangeland (3) Devide the total 5 hectare land into six plots. (4) water for drinking and irrigation from nearby rives, in west side of rangeland, using 1.2 inch polyethylene pipe (5) Seed sowing: Year 1: sow forage seed in Plot 1 and 2, (2) Year 2: sow forage seed in plot 3 and 4 (3) Year 3: sow forage seed in plot 5 and 6. (4) Fodder use: They can use the fodder from plot number 1 and 2 in year3. Now they can use the plots in rotation in the years to come. They should use white clover and rye grass to get maximum fodder from the improved plots. DLSO Ilam provided some pasture seed but not established as farmers were not trained to manage rangeland.

(2) **Product value chain:**Churpi is locally sold but the quality is of high quality. They can make

Paneer and sold to Santapur of Ilam (hill station in the Indian boarder with huge number of Bengali tourist from India.)

(3) Capacity Development: The group have not received training about the rangeland management and milk product processing. This group can be used to promote the rangeland management for chauri and goat production under the NLSIP project.

Figure 36: Group discussion at Falelung and Chitre of Ilam and Panchthar about the Rangeland management (By Animal feed and Nutrition Specialist C.R. Upreti) during filed visit

11.6 Fodder crop and Agro –forestry Development

Major fodder tree species available in NLSIP are shown in Annexure 2. But some fodder species available in rangeland districts are as following:

(1).Khasru (2) Banjh (3) Bainsh (4) Chuletro (5) Ningalo (6) Bhalu chinde

11.6.1 Management and lopping protocol of fodder trees available in NLSIP districts

Lopping of fodder trees plays a major role to get more production from the tree. Currently, lopping protocol of fodder has not been adapted by the farmers. The description of major fodder trees have been given in Annexure 3.Badahar, Ipil ipil, Kutmiro, Mulbery, Pakhuri, Bakainu, Tanki, Ginderi, shyal Fushro fodder tree can be lopped for longer period. Only Ipil ipil can be harvested four time in a year. Fodder should not be harvested during the Flushing month as indicated by XX. (Table 36). If the fodder are lopped without considering the lopping month, the impact for plant and animal will appear, therefore, it is recommended that fodder tree should not lopped during flushing months (as indicated by XX)

Table 36: Lopping and leaf flushing calendar of fodder (top 15 major fodder species)

Fodders trees	Month of lopping											
	August	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**July**
1.Badhar (*A. Lakoocha*)			√	√	√	√	√	√	√			
2.Kavro						√	√	X	X	√	√	
3.Khashru					√	√	√	√	√	X	X	X
4.Kutmiro				√	√	√	√	√	X	X		
5.Khnyu					√	√	√	X	X			
6.Nimaro					√	√	√	√	X	X		
7.Ipil ipil	√			√			√			√		
8.Mulbery				√	√	√	√	√	X	X		
9.Pakhuri		√	√	√	√	√	√	√				
10.Bakainu		√						√	√	√	√	√
11.Bainsh												
12.Dabdabe						√	√	√	√	X	X	
13.Tanki				√	√	√	√	√	X	X		
14.Ginderi			√	√	√	√	√	X	X			
15.Shyalfushro				√	√	√	√	√	X	X		
Months	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July

Source: FAO/FANEP03/ 2012. By C.R. Upreti.Pp 1-50.
Note: (1) √ = Lopping, and X = flushing months.

The impact of improper lopping on both animal and plants are as follows;

(1) Fodder Tees: Lopping during flushing months: tree will die

(2) Animal: Feeding the fodder twigs harvested during flushing (i.e. X months) contain high level of polyphenolic compounds (i.e. oxalates/tannin) that affects the host animal.

11.6.2 Fodder Nursery

Recent assessment of fodder tree and agro forestry have shown that fodder plantation and conservation is important. The fodder nursery are not adequately available in the project area. The seedlings of top ranking fodder species, as shown in Annexure 3 needsto be developed in fodder nursery during June to July to use to develop agro forestry system.

11.6.3 Agro-forestry Establishment and Management in Terai, Hills and Mountain

There are potential farm land to develop the agro-forestry and Hoerto –pastoral system of fodder production in Nepal particularly in Hills and mountain region of Nepal. The potential NLSIP districts are (a) Agro forestry: Tanahun, Palpa, Argakhanchi, Syngham Gulmi, Hyagdi, Makwanpur, Kavrepalnchok, Nawalpur.(b) Hori-pastoral: Mustan, Manag, Kaski,

Suitable Fodder crop under Agro forestry Management system

Shed loving forage crops should be planted underneath the fodder tress. The potential fodder and forage crops are shown in Table 37. Millet is commonly cultivated under the fodder trees with less affect on grain ptoductionTere are other some grain grops available in Nepal suitable under ageo forestry and, horto pastural system but not fully studied.

Table 37: Suitable fodder crop under agro forestry management system

SN	(a) Agro forestry		(b) Hori-pastoral	
	Grain Crop	**Fodder crops**	**Fruits tree**	**Pasture crops**
1	Millet	Ipil ipil	Apple	Clover
2	Millet	Rye Khanyu	Apple	Rye grass
3	Millet	Tanki	Pears	Cocksfoot
4		Koiralo	Orange	Clover

Source: NARC 2000 several reports

11.7 Forage seed production dynamics

11.7.1 Farmers'level

Cultivation of forage crops for seed production is limited in NLSIP project districts. Seed production has not been commercialized yet in in Nepal except in some selected pockets of a NLSIP districts. Some districts, other project and outside the project are (1) Project districts: Dhanusha, Makwanpur, Chitwan, Rupandehi, Kavre, Banke, Palpa, Morang, Sunsari, Jhapa, Saptari, (2) Other districts: Mahottari, Sarlahi, Bara, Dang, Surkhet, and others. These districts are producing fodder sees like Berseem, Oat, Vetch, Stylo, Joint vetch, Molasses and Teosinte. Farmers are more interested to grow fodder seed in the project deistricts as shown the interst during the recent NLSIP State Level Workshop in Biratnagar, Hetaunda, Butwal and Pokhara.

Problems faced by the farmers:

State level workshop and other review indicated the following problem faced by the forage seed grower;

(1) Forage is still considered as a minor crop

(2) Farmers have little excess to technical backstopping from the forage experts.
Therefore the seed grower have limited technological options. But in the recent year with the commercial dairy farm, farmers are motivated to grow the forage seed in medium to large scale. Farmers are in the project district are benefited from the Forage Mission launched by DLS in the recent years.

(3) Lack of marketing network of seed marketing
Like in dairy product and other cereal crop, fodder seed do not have organized seed marketing network. Recent field survey has indicated the possibility of using Agro Vet and local level milk cooperatives in forage seed marketing.
Public Sector (Government Sector)

Limited number of Pasture and Forage Development/research Farms/Station under DLS and NARC located at different ecological zone of the country are only the public sector agencies producing forage seed(Table 38). The seed production share of the government farmer to produce the seed is very small but plays a significant role in regulating the price for major forage seed traded in the markets.

Table 38: Forage seed productivity of selected species (kg/year) in governmentfarms/stations

Farms/ Stations	Forage seed (kg/h)						Pasture Crop	
	Oats	Berseem	Vetch	Joint vetch	Teosinte	Stylo	Clover	Rye Grass
1.BRP, Tarahar, NARC	2800.0	-	-	-	4000	-		
2.RARS, Nepalganj, NARC	2800.0							
3.RARS, Parawanipur, NARC	2900.0							
4.Rhz.Forage Seed Lab Janakpur, DLS	900.0	450	650	-	770	-		
5.Forage Genetic Resource Canter Ranjitpur/DLS	1000.0	500.0	650					
6.Pasture Research Station Rasuwa/NARC								
7.Sheep Goat R.P. Jumla/NARC								
8.Cattle Genetic Resource Center, Jiri								
9.Goat Research Station,Bandipur/NARC								
10 Nationa Animal Breeding Office, Pokhara								
11.Pasture and Fodder Division, Khumaltar/NARC								

Source: Forage seed production area mapping TLDP, 2002 Pp19-39. (2) Annual Reports of Farms and Stations of various year.

11.8 Non-conventional minor forage crops

There are some potential non-conventional feed that can be used to dairy animal feeding. Some of them are (1) Azolla (*Azolla pinnata*) (2) Thornless cactus (Figure 36).

(1) Azolla (*Azolla pinnata*):

Azolla pinnata is widely occurring in all the mid=hills and Terai region of Nepal (FAO 2082). Adhikari et al 2014 reported the Azolla production technologies and its utilization in rice farming in Nepal. Premi et al 2019 are working on the production and feeding of Azolla in Butwal under the KUBK prokram. Swisscontact 2019 is also doing action research on Azolla feeding in Terai and hills of Nepal (Adhikari et al 1915).

Multipurpose fodders

Some multipurpose fodder are (1) Maringa (2) Mulberry pant. There are multipurpose plant suitable for fodder and adaptive to climate change in the line to hot. Mulberi contributes to mitigate the methane in ruminant animal.

Azolla: Demonstrattion at KUBK Nepal for model dairy 20 June, 2019. Photo Dr. K.Premi

Moringa pant and it properties

Moringa leaves ready to feed to the animal and well aadopted in Nepal (FAO 2018)

Thornless Cactus for animal feeding

Figure 37:Some potential minor non-conventional fodder crops

1. Moringa (*Moringa oleifera*)

This is a multipurpose fodder crop with medicinal value. This fodder crop is widely promoted by FAO 2019 Upreti, (2018) under the FAO/Climate Change Adaptation Project in NLSIP districts such as (1) Udayapur (2) Siraha (3) Kapilvastu and (4) Argakhanchi. The field performance is very good and farmers have preferred this crop. This is very good fodder crop to support the livelihood of the livestock keeper in Taeai and hills of Nepal. Expect Manag and Mustang in all 26 project district can promote this fodder crop for animal feeding and as vegetable for human consumption. Thornless cactus is suitable for Terai region of Nepal i.e terai districts of NLSIP project.

11.9 Forage seed Act and seed certification

11.9.1 Seed act 2045 and seed Regulation 2054 B.S

Seed act 2045 and Seed Regulation 2054 B.S. is the legal document to maintain the seed quality in the country. Seed Act article Number 2.1.2 clearly includes and define the forage seed under the Seed Act 2045. But this Act and Regulation are not fully executed as far as the fodder seed concerns. With the increasing fodder seed demands, the DLS is working with SQCC to prepare the Forage Seed Quality Reference Standards for fodder seed quality management in the country, NLSIP can work with SQCCE to prepare the “Forage Seed Quality Reference Standard: to promote the quality fodder in the country.

11.9.2 Truthful label of forage seed

With the initiation of the DLS, SQCC has prepared the Truthful Label of Forage Seed (TLFS) in 2070 B.S. and executed in the field. The Truthful Label is only for 210 fodderspecies and many more are left behind(Table 39). The TLFS should be revised and updated where NLSIP can work.

Table39: Truthful Label of Forage Seed (Gov./DLS)

SN	Name of forage Crops	Scientific Name	Purity % Minimum		Germination % Minimum	
			CS*	TL	CS*	TL
1	Berseem	*Trifolium alexandrinum*	98	97	80	80
2	Oat	*Avena sativa*	97	98	85	85
3	Kote	*Medicago fulcata*	98	97	80	80
4	Dinanath	*Pennisetum pedicilatum*	95	94	50	50
5	Sorghum	*Sorghum bicolour*	97	97	75	75
6	Guine grass	*Penicum maximum*	70	70	20	20
7	Stylo	*Stylosanthes hamata*	90	90	45	45
8	Teosinte	*Euclaena maxicana*	98	98	80	80
9	Setaria grass	*Setaria anceps*	60	60	40	40
10	White clover	*Trifolium repens*	93	93	65	65
11	Rye grass	*Lolium multiflorum*	97	95	65	65
12	Cowpea	*Vigna sinensis*	98	98	70	70
13	Cocksfoot	*Dactylis glomerata*	80	80	60	60
14	Ipil ipil	*Leochaena lecocephala*	98	98	60	60
15	Molasses	*Melinis minutiflora*	40	40	30	30
16	Paspalum	*Paspalum dilototum*	60	60	60	60
17	Desmodium	*Desmodium intortum*	94	92	70	70
18	Siratro	*Macrotillum atropurpureum*	97	97	70	97
19	Winter vetch	*Vicia sativa*	98	98	70	70
20	Joint vetch	*Aeschynomene americana*	95	93	50	50
21	Kudzu	*Pueraria thunbergiana*	98	98	75	75
22	Lab lab	*Lablab purpureus*	93	93	65	65

Source: Gov. DLS, National Pasture and Animal Nutrition Center, 2070 B.S. Commercial Forage Seed Production and Commercialization Program OperatorPp 25-26.

Note: * Proposed Purity % and Germination % certified Seed

TL: Truthful Label of Forage seed, CS: Certified Seed.

Chapter 12
Calf Rearing Program

Todays' calves are tomorrows' cows. During the field visit, growing calves were found to be suffering from various deficiencies with stunted growth and rough skin coat. As a result, age at first calving is 4-5 years, inter-calving interval is longer and lactation length is shorter. It is proposed that in the project areas calf rearing program will be launched, wherein, pregnant animals in the last two months of lactation will be fed special pregnancy feed. Calves thus born shall be healthy and fed with calf starter and calf growth meal. This will be helpful in reducing age at first calving significantly and increase lactation length. The program will be run for demonstration purpose in the limited project areas, graded and cross bred animals.

12.1 Introduction

The calves of today are the milking cows of tomorrow. The performance of any individual animal is dependent on its genetic potential, feeding and management. Cross breeding has increased the yield potential of cows to some extent, but most of cows and buffaloes especially indigenous are unable to express their full genetic potential for milk production due to poor growth rate and inadequate nutrition during their early phase of growth.

Growth phase of the animals is confined to the first two years of its life. It is important that the calf is given nutritious feed in the form of concentrates or fodder right from its foetal stage. This will ensure birth of healthy calf and yield good milk when the calf becomes a cow. From health point of view, the life of a calf is divided into two parts; the first 24 hours and the rest. The first 24 hours of life of a calf is so important that it has a strong bearing on the rest of its life.

Cows and buffaloes in Nepal are robust and resilient and are particularly suited to the climate and environment of their respective breeding tracts. They are endowed with qualities of heat tolerance, resistance to diseases and the ability to thrive under extreme climatic stress and less than optimal nutrition. Due to inadequate nutrition and poor growth rate in early life, dairy animals are not able to produce milk commensurate with their full genetic potential, even if they are fed optimally.

The potential to enhance the productivity of indigenous as well as crossbred cattle and buffaloes through better nutrition and good management is immense. This could be achieved through better feeding and management of buffalo and cow calves during their early life. It is high time that focus should be shifted to scientific calf rearing of cattle (both indigenous and crossbred) and buffaloes so that better healthy animals can be made available to the milk producers.

On an average, it is assumed that the calf will come to puberty around 20-24 months of age and will become a cow/ buffalo by calving for the first time around 28-38 month of age, if fed and managed scientifically. However under field condition animal's age at first calving is around 40-45 months in cows and 46-52 months in case of buffalo. Hence, Calf Rearing Programme through nutrition management will improve the situation under field condition in Nepal.

12.2 Benefits of calf rearing program

- Calves born are healthy, as essential nutrients are provided during advanced stage of pregnancy.
- Better immunity in calves and protection against diseases.
- Reduction in mortality rate for rearing female buffalo and cow calves by following scientific feeding & management practices.

- Reduction in age at first calving by improving daily growth rate and achieving early maturity weight by feeding calf starter & calf growth meal.
- Increase fertility both in the heifer and in first-lactating animals.
- Increased milk yields during first and second lactation.
- Improvement in life time productivity & productive life of animals, by rearing calf at farmer's doorstep which could be more disease resistant & would have better feed conversion efficiency.
- Reduces feed and labour cost during rearing.

12.3 Nutritional management of advanced pregnant animals

Management of advance pregnant animal is very crucial because animal is under pregnancy stress as foetus is developing rapidly during last 3 month of pregnancy, so adequate care needs to be given during this time. Such animals should not be taken far away for grazing and also uneven paths should be avoided. A lactating animal should be dried with in the period of 15 days after the 7^{th} months of gestation which allow a minimum dry period of 45-60 days.

Pregnant animals should have enough space for standing and sitting comfortably.

Proper and balance nutrient should be supplied during last trimester to ensure optimum foetus growth, rebuild body energy reserves, regenerate milk secretory tissues and to avoid incidence of metabolic disorders. As dry matter intake is decreased due to pressure of foetus on rumen especially last 60 days of gestation, so nutrient in dense form like quality protein meals, bypass fat & higher level of grains which is easily digestible should be provided to meet its higher requirement of crude protein, energy, minerals and vitamins. All vitamins requirement especially vitamin E have been increased many fold due to its anti-oxidant property as animal is under stress.

Dietary cationic-Anionic balance (DCAB) should be taken into account while feeding mineral mixture; as negative DCAB (acidic) will stimulate parathyroid hormone (PTH) which in turn increase the mobilization of bone calcium, reduction in urinary Ca loss and also activate 1,25 dihydroxycholecalciferol (active form of vitamin D_3) enhance the intestinal Ca absorption. So at the time of calving, all mechanism which maintains plasma Ca concentration will be activated to meet higher Ca requirement for milk production & it will prevent the chances of milk fever.

Water should be provided round the clock to pregnant animals with a minimum of 70-80 litres of fresh and clean drinking water daily.

Before 4-5 days of calving, the animals should be tied in a separate clean and airy area having sunlight. Bedding materials like paddy straw should be spread on the ground for the animals. The animal should be kept under observation during the last 1-2 days before calving.

Precaution to be taken during dry period

- Minimum 45 days of dry period should be provided.
- Over-conditioning of close-up cows
- High calcium or potassium intake.
- Heat stress in late gestation.
- Sudden changes in ration ingredients

As animal undergoes a lot of stress while calving and immediately after calving the animal has a low appetite and will not eat as much feed as the body may require to compensate the requirement for milk production, therefore animal should be given light palatable, mild laxative ration in dense form containing warm rice gruel, boiled rice/wheat bran, boiled millet or wheat mixed with edible oil, bypass fat, jaggery, soya, asafoetida, methi, black cumin, ginger etc. for 2-3 days after calving. This kind of diet is also helpful in early expulsion of placenta. In addition, the animal should be given tender green fodder and fresh water as much as it want to drink, but do not give hot water. Ensure the milking cow has constant access to clean drinking water and receives required quantity of mineral mixture daily.

12.4 Nutritional management of calf

After birth of calf, first thing is to clean nostril & mouth and massage the chest which help the calf breathe comfortably and help prevent future breathing problems. Allow the mother to lick the calf clean which promotes circulation within the calf body and prepares the calf to stand up and walk. Insert 2 fingers in the mouth and place them on the tongue, which will help the calf to start suckling. Tie the navel cord with a thread at a distance of around 2 inches from the base and cut the remaining cord with clean instrument. Dip the navel in 7% or higher tincture of iodine solution and repeat after 12 hour. De-worming should be done within 10-14 days of age subsequently on a monthly basis up to 6^{th} month.

12.4.1 Colostrum feeding

Colostrum is the first secretion produced by the mammary gland of cows/buffaloes after calving, a rich source of protein, fat, minerals and antibodies. New born calves have very low resistance to diseases; buffalo calves have an ever lesser resistance to disease as transport of antibodies from dam to calf through placenta is very low. So colostrum is invaluable gift of nature to new born calf.

As the first hour after calving is the *golden hour* i.e. most critical period for the entire life of a calf because of its ability to absorb maternally derived immunity in the form of immunoglobulin (antibodies) present in colostrum through intestinal pores present in gut and transport them into bloodstream. Antibodies transferred from dam to calf in this way are referred to as "passive" antibodies. Colostrum is the calf's *"Passport of Life".* A calf must receive adequate colostrum to protect from diseases for the first three months of its life. Around 2 litres of colostrum should be given within first 1-2 hour of birth in 2-3 meals. Hand feeding new-born calves is therefore recommended so that the farmer is sure about the amount of colostrum an individual calf receives.

Following are the five golden rules to colostrum feeding

1) **Quick:** The calf should get colostrum as quickly as possible after birth. The ability of the intestine to absorb antibodies from colostrum into the blood is maximum within the first hour following birth and remains fairly good for up to six hours of life. At about 12 hours after birth the absorption of immunoglobulin is reduced by 50% and after 24 hours the calf can hardly absorb any antibodies at all.

2) **Quantity:** To provide the calf with enough energy, nutrients and antibodies, calves should get as much colostrum as possible. Protein, fat and sugars from colostrum help to increase the calf's metabolism and heat production. Moreover, colostrum acts as a mild laxative as it helps removing residue i.e. the passing of first stool (meconium) from the intestine of newly born calves. Ideally calves should receive 10% of their body weight for whole day and two to three litres of colostrum within 2-3 hours after birth.

3) **Quality:** Colostrum should contain at least 50g/L of IgG. Colostrum with <50 g/L IgG will not provide an adequate amount of protection to the new-born calf, even if it is fed immediately after birth.

4) **Frequency:** The calf should receive multiple colostrum feedings by bottle during the first day of life. Research has proven that calves that are stressed when receiving colostrum will not absorb the protective antibodies as efficiently as those that are calm.

5) **Cleanliness:** Strict hygiene standards for cleaning and sanitation should be observed when milking a fresh cow. The udder as well as the recipient should be thoroughly cleaned. If this is not done the colostrum can expose the gut of the new-born calf to a high level of bacteria, thereby decreasing the absorption of immunoglobulins.

12.5 Calf starter and calf growth meal

Optimum level of nutrition in early life favors faster growth, earlier onset of puberty and enhanced productivity. Calves need to be reared to obtain optimum gain in body weight, so that they attain about 75-80 per cent of mature body weight at puberty. Calf starter is a balanced concentrate mixture, comprising ground cereal grains, protein supplements, minerals and vitamins. Calves should be encouraged to consume maximum amount of calf starter as that would enhance growth rate. After about six months, calf starter should be replaced with calf growth meal, which is more economical for growing calves.

Feeding calf starter and good quality leguminous hay from early life, stimulates early development of rumen papillae (rumen wall), essential for rumen functions, which favour digestion of larger proportion of fodder at an early age. Starter grain is fermented in the rumen to create volatile fatty acids, which equals energy. The volatile fatty acids need water and starter. Hay offers a scratch factor to keep rumen papillae from forming keratin layers that reduce absorption. One good strategy would be to increase feeding hay slowly. Forages of consistent particle size are beneficial for both rumen development and calf performance and have the potential to be economically viable.

Chapter 13
Greenhouse Gases (GHGs) Emission Reduction

It has been documented that the ruminant animals fed on imbalanced diets produce more greenhouse gases (GHGs) responsible for global warming. Imbalanced diets produce more hydrogen ions in the rumen which are removed in the form of methane, later being the hydrogen sink. In addition, nitrogen excretion through manure is higher on imbalanced diets. Nitrogen excreted through manure is converted to nitrous oxide, a most potent GHG.

Through this project, various initiatives aimed at improving productivity and productive life of various livestock species would help balancing the nutrients in the diet of animals, thus, improving productivity and reducing GHGs emission. GHGs emissions per litre milk be calculated in animals with and without interventions and an estimate will be prepared on approx. how much GHGs emissions are likely to be reduced per litre of milk production.

It will be demonstrated that the productivity enhancement programs taken up under the NLSIP are environmentally sustainable.

13.1 Introduction

Climate change, the most serious environmental challenge humanity has to face is threatening the well-being of the future generations by transforming our planet's ecosystem. Global surface temperature change for the end of the 21st century is likely to exceed 1.5 to 2.0 ^{0}C relative to 1850 to 1900 (IPCC, 2013). Continued emissions of anthropogenic greenhouse gases (GHG) will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystem. Livestock are believed to be a significant contributor of climate change, representing 14.5% of global anthropogenic GHG emissions. Worldwide, dairy and beef production account for 20% and 41%, respectively, of the emissions of this sector followed by buffalo milk and meat, with 8% of the emissions (Gerber *et al.* 2013).

The global demand for milk and milk products is expected to double by the middle of the century due to rapid population growth and shifting trends in consumption patterns, and most of this demand will be in developing countries. Annual per capita consumption of milk and milk products (fresh milk equivalent) in developing countries is expected to increase from 52 kg (2005) to 76 kg by 2050 (Alexander and Bruinsma, 2012). A World Bank report projected an exploding size of the South Asia's middle class by 2050 – from under one million at present to some 660 million in 2050 (Van der Mensbrugghe*et al.* 2011). Such developments can be expected to have a significant impact on the region's GHG emissions.

13.1 Methane production in ruminants

Methane is one of the most potent GHG responsible for climate change. Fermentation of feeds in the rumen is the largest source of methane (CH_4) from enteric fermentation and is primarily emitted from the animal by eructation. The conversion of feed materials to CH_4 in rumen involves the integrated activities of different microbial species, with the final step carried out by methanogenic bacteria. Methane and CO_2 are natural by-products of microbial fermentation of carbohydrates and, to a lesser extent, amino acids in the rumen and the hindgut of animals. Methane is produced in strictly anaerobic conditions by highly-specialized methanogenic prokaryotes, all of which are archaea. In ruminants, the vast majority of enteric CH_4 production occurs in the reticulo-rumen, while rectal emissions account only 2 to 3% of the total CH_4 emissions in ruminants (Muñoz *et al.* 2012).

Animals fed on imbalanced ration produce more methane per unit of dry matter intake due to lower microbial protein production and higher acetate production. Amongst the volatile fatty acids produced in the rumen, acetate and butyrate are methanogenic and spare hydrogen during their formation, while propionate is glucogenic in nature and utilizes hydrogen. More acetate and butyrate production leads to production of more hydrogen and carbon dioxide, the main substrates for methane production. Balanced diet alters rumen fermentation pattern towards the lower acetate, butyrate and higher propionate production. In view of this, methane emission was measured in field animals before and after feeding the balanced ration.

Strategies for reducing enteric methane emissions

Various strategies, mainly focusing on feeding, breeding and rumen manipulation have been studied for reducing enteric methane emissions. All these strategies include feeds and feeding management like feed intake, feeding frequency, feed processing, inclusion of concentrates, forage quality, forage preservation, ration balancing; feed additives like ionophores, probiotics, enzymes, dietary lipids, inhibitors, propionate enhancers, secondary plant metabolites, bacteriocins; rumen manipulation like defaunation, vaccination, ruminally produced bacteriocins and archaeocins; and breeding like animal and plant breeding have been published (Cottle*et al.* 2011; Goel and Makkar, 2012). Most of these approaches are inept for long term use because of their limit. Further, many of these approaches require years of research before practical application and commercially viable products are available.

For developing countries like Nepal, the strategies for reducing methane emission should be cost-effective and should also address socio-economic issues of the society. Bayat and Shingfield (2012) has documented that the dietary manipulation to induce changes in rumen fermentation characteristics remains the most feasible approach to achieve reduction in methane emissions. Hristov*et al.* (2013) has also documented that increasing animal productivity by providing nutritionally balanced feed is the most economical and practical strategy for reducing enteric methane emissions for smallholder mixed crop-livestock systems in tropical countries. In this situation, ration balancing using locally available feed resources and area specific mineral mixtures helps in improving the productivity of dairy animals, by way of increasing feed conversion efficiency, microbial protein synthesis, and thereby reducing methane emissions from ruminants.

Effect of ration balancing on methane emission, manure nitrogen excretion and carbon foot print of milk

Large scale implementation of RBP in India increased net daily income by way of increasing daily milk yield, and/ milk fat level, while decreased the cost of feeding. In addition, enteric methane emissions and manure nitrogen (N) excretion were decreased, while feed conversion efficiency and microbial N synthesis were improved. Balanced feeding also helped in reducing carbon footprint of milk.

Methane emissions

To quantify the impact of ration balancing on methane emissions under field conditions, NDDB of India has undertaken methaneemission measurement studies in different agro-climatic regions of the country, using sulphur hexafluoride (SF_6) tracer technique. Methane emission measurements were carried out in 162 early lactating cows and buffaloes, before and after feeding a balanced ration and the CH_4 emissions reduction on feeding a balanced ration was measured per kg of milk production.

Studies indicate that balanced feeding has reduced CH_4 emissions (g/ kg MY) by 15-20% in lactating cows and buffaloes. Result of these studies indicate that the balanced feeding has the potential for improving milk production efficiency and reducing methanogenesis with an increase in net daily income of milk producers (Garg and Sherasia, 2015).

13.2 Manure nitrogen excretion

Garg *et al.* (2016a) conducted a field study on 7090 lactating cows and 4534 lactating buffaloes to evaluate the effects of feeding balanced rations on manure nitrogen excretion. Study showed that average dietary nitrogen intake (NI) reduced ($P<0.05$) by 14.1% on feeding a balanced ration. Thus, the percent dietary N excretion in manure reduced ($P<0.05$) from 81.6 to 78.0%, indicating improved nitrogen use efficiency (NUE) from 0.18 to 0.21 in cows and buffaloes. Result demonstrates that balanced feeding reduced manure nitrogen excretion, thereby reducing emission of nitrous oxide; a potent greenhouse gas.

13.3 Carbon footprint of milk

A cradle-to-farm-gate life cycle assessment (LCA) study conducted by Garg *et al.* (2016b) indicates that after feeding a balanced ration, average carbon footprint of milk reduced ($P<0.01$) from 1.6 to 1.1 and 2.3 to 1.5 kg CO_2-eq/kg fat and protein corrected milk in cows (n=1,63,540) and buffaloes (n=1,63,550), respectively. Emissions of methane from enteric fermentation, methane from manure management, nitrous oxide rom manure management contributed about 69.9, 6.3 and 9.6% in cows; and 71.6, 7.4 and 12.6% in buffaloes, respectively, to the baseline lifetime total greenhouse gas (GHG) emissions. Present LCA indicates that, the methane from enteric fermentation is the largest contributing to total GHG emissions in smallholder dairy production system of India.

Based on the above findings, milk production potential of dairy animals in project districts of Nepal will be enhanced in an environmentally sustainable manner.

Chapter 14

Use of Bypass Protein Feed for Enhancing Milk Production

Protein meals such as rapeseed meal, groundnut meal, sunflower meal, guar meal, soybean meal, cottonseed meal etc., can be treated suitably, so as to reduce degradability of the proteins in the rumen from 60-70% to 25-30%, in a specially designed airtight plant. Protein meal identified for the treatment is first ground to 3 mm particle size, treated chemically at appropriate level and then stored for 9 days under airtight conditions. After 9 days of incubation, protein meal is ready for feeding to animals and it can be even stored for more than a year, without any deterioration in quality. Treatment does not at all affect colour, flavour or taste of protein meal.

Introduction

Protein forms one of the most significant constituents of the ruminants' ration. It is therefore of paramount importance to ensure that this constituent is utilized with high efficiency. Protein is usually the first limiting nutrient for cattle fed low quality forages. Protein is necessary for rumen microbes to digest fibre and other feedstuff components. All ruminants, including dairy animals, derive their protein requirement from two sources. One is rumen un-degraded feed protein that gets enzymatically digested in the abomasum and small intestine and another source of protein is rumen microbes. If dietary nitrogen intake of ruminant animals is manipulated in such a way, so as to maximize amino acids availability from rumen microbial output and un-degraded dietary protein, then the growth and milk production in animals can be maximized with marginal increase in feed cost.

Protein meals, particularly rumen escape proteins play a very important role as excellent protein supplement in livestock feeding. When these meals are fed as such to the ruminants, about 70 per cent of the protein is broken down to ammonia by the rumen microbes in the rumen and a significant portion is converted to urea in liver and excreted in the form of urea through urine.

However, if these protein meals are subjected to the suitable chemical treatment – termed as **"bypass protein technology"**, then their efficiency of utilization can be significantly improved. The bypass protein supplement provides essential amino acids to be available for absorption at the small intestine. When chemically treated protein meals replace untreated one, then due to less degradability of the protein, excessive loss of both nitrogen and energy could be avoided, resulting in an increased energy and nitrogen balance, leading to increase in milk yield and milk constituents.

14.1 Bypass protein feed technology

In recent years, several technologies have been developed through the intensive efforts of animal nutrition research, one of them is bypass protein feed technology. The main aim of this technology is to increase the efficiency of protein utilization in ruminants for enhanced milk production. Dairy nutritionists are trying to enhance the nitrogen utilization through dietary manipulation to have optimum milk production. Manipulation of protein degradation or the efficiency of nitrogen utilization in the rumen is the most effective strategy to reduce nitrogen losses in dairy animals. Losses of nitrogen can be reduced by balancing the ration with optimum ratio of rumen degradable protein (RDP) to rumen undegradable protein (UDP) and increasing nitrogen use by ruminal microorganisms.

Proper RDP: UDP optimizes post ruminal amino acid supply for productive purposes. Efficient utilization of proteins by ruminants in any production system depends on knowledge of the underlying basic principles. However emphasis is given to the requirements for dietary proteins that escape from the rumen and are available for digestion. Thus, bypass proteins refer to the dietary proteins that escapes rumen degradation, more precisely aims at decreasing the wasteful ammonia production in rumen from highly degradable protein meals and thereby, increasing the availability of essential amino acids at intestinal level. Average UDP level of different protein meals are given in Table 40.

Table 40:Rumen un-degradable protein (UDP) level of some untreated protein meals

Sr. No.	Protein meal	CP (%)	UDP (%)
1	Rapeseed meal	37.0	34.0
2	Sunflower meal	28.0	31.0
3	Soyabean meal	46.0	36.0
4	Groundnut meal	39.0	33.0
5	Guar meal	48.0	39.0
6	Cottonseed meal	38.0	51.0

14.2 Production of bypass protein feed using chemical treatment of protein meal

Usually, protein meals are fed as such to ruminants in Nepal, which have variable degree of naturally rumen protected proteins. The solubility of protein does change when subject to special treatments, advantage of which is to protect good quality proteins from rumen degradation. Number of methods like alkali treatment, xylose treatment, heat treatment and formaldehyde treatment were tried to protect the proteins. Amongst all, formaldehyde treatment of protein meals for production of bypass protein feed has the advantage of being the cost effective technology for protection of highly degradable proteins in rumen, without having any adverse effect on the animal’s health and on milk quality. Bypass protein supplement manufacturing plant is shown as Figure 38. This method has been extensively used because of the following advantages:

- Desired level of protein protection can be achieved.
- Under and over protection of proteins can be eliminated.
- The bio-availability of the essential amino acids can be maximized.
- It does not increase the proportion of acid detergent insoluble nitrogen (ADIN) and neutral detergent insoluble nitrogen (NDIN) content.
- Less expensive than heating.
- Helps to control salmonella and reduce mould growth in feedstuffs.

Characteristics considered to be desirable for protected protein supplements

- High level of crude protein.
- Optimal essential amino acids profile.
- About 70-75 per cent of the protein to be in a rumen un-degradable form (UDP).
- Approximately 80% of the rumen un-degradable protein to be digestible in the small intestine.

Figure 38: Bypass protein supplement manufacturing plant

Nutritional properties of formaldehyde treated protein meals

Usually, rumen degradability of crude protein from protein meals is in the range of 50-75 per cent. As a result, net availability of amino acids for milk production is low. If these protein meals are given suitable chemical treatment to reduce rumen degradability of protein to 25-30 per cent, net availability of amino acids could be increased for milk synthesis. The amount of formaldehyde required to optimally protect protein in different protein meals, without decreasing the digestibility of protein and essential amino acids is very important (Hamilton *et al*. 1992; Ashes *et al*. 1995). If excess formaldehyde is used to protect protein, then the complexes formed between formaldehyde and amino group of protein are acid resistant (Ashes *et al*. 1984) leading to reduce protein digestibility and bio-availability of essential amino acids at intestinal level. In effect, the protein will be "over protected" from ruminal degradation and metabolism.

14.3 Effect of feeding bypass protein supplement on milk production

Scientific studies conducted on bypass protein supplement revealed that the feeding of bypass protein to growing animals increased growth rate (25-30%). It also resulted in reduction in rearing cost and in attaining early maturity of the calves. It has also been shown that bypass protein feeding improves the reproductive efficiency of breeding bulls (Walli, 2009).

In India, Dr Garg and his team conducted many studies to evaluate the effect of feeding formaldehyde treated protein meals on milk yield and net daily income of farmers. Feeding trials conducted with different levels of formaldehyde treated protein meals indicated that feeding of 1.0 kg treated protein meal was optimal and produced 1.1 litres more milk, 0.2% more fat and 0.3% more protein with a net gain of about Rs. 9.61 per animal per day over that of control group (Garg *et al*. 2002; 2004).

Similarly, one kg feeding of treated rapeseed meal increased milk yield 1.1 litres, fat % 0.2 and protein % 0.2 with a net gain of Rs. 9.44 in the feeding trial carried out in an organized farm (Garg *et al*. 2003a). In another feeding trial carried out with treated guar meal, it was observed that a kilogram feeding of formaldehyde treated guar meal, increased milk by 0.90 litres, fat by 0.2% and protein by 0.2% with net gain of Rs. 8.60 (Garg *et al*. 2003b). Feeding trial using treated rapeseed meal was also conducted in low yielding crossbred cows. The results indicated that milk yield (litre), fat (%) and protein (%) were increased by 0.7, 0.2 and 0.2, respectively in experimental group as compared to that of control group (Garg *et al*. 2005a). Summary of feeding trials is given in Table 41.

Table 41: Summary of feeding trials on bypass protein as top feed

Feeding trial with treated meal	Increase in comparison to control			
	Milk (Lt.)	Fat (%)	Protein (%)	Net income (Rs./ani./day)
Sunflower meal in cows	1.00	0.30	0.20	9.85
Rapeseed meal in cows	1.10	0.20	0.20	9.61
Rapeseed meal in cows	0.90	0.30	0.10	9.25
Guar meal in cows	0.90	0.20	0.20	8.60
Sunflower meal in buffaloes	0.80	0.40	0.30	14.49
Rapeseed meal in low yielding cows	0.70	0.20	0.20	5.80

In buffaloes, the response was relatively better than in cows. Feeding trial carried out in buffaloes showed that one kilogram feeding of treated sunflower meal produced 0.80 litres more milk, 0.4% more fat and 0.2% more protein with a net daily gain of Rs. 14.49, compared to that of control group (Garg *et al*. 2003c).

Garg *et al*. (2005b) conducted a study to assess the economic benefit of feeding bypass protein feed in Vadodara district of Gujarat State of India. Study revealed that the average increase in net daily income was Rs. 9.20, 6.42 and 12.41 in indigenous cows, crossbred cows and buffaloes, respectively. In the present study, supplementation of formaldehyde treated bypass protein feed was found to be economical for milch animals producing on an average 5-8 litre of milk per animal per day. Thus, formaldehyde treated protein meal – bypass protein feed is considered as an economical way to increase the net daily income of milk producers. A specification for production of bypass protein feed is given in Table 42.

Advantages of feeding bypass protein supplement

- Cheaper source of protein for animals
- Increases availability of essential amino acids.
- Improvement in milk production.
- Easier to meet the requirement of high yielding animals.
- Improvement in fat and SNF per cent.
- Helps in increasing net daily income.
- Better growth in young animals.
- Improved reproduction efficiency.
- Better resistance against diseases.
- Helps to control salmonella and reduce mould growth when used with cattle feed.

Table 42: Specifications for Bypass Protein Feed

Sr. No.	Characteristic	Requirement
1	Moisture, percent by mass, Max.	11
2	Crude protein (N x 6.25), percent by mass, Min.	22
3	Crude fat, percent by mass, Min.	4
4	Crude fibre, percent by mass, Max.	10
5	Acid insoluble ash, percent by mass, Max.	3.0
6	Common salt (as NaCl), per cent by mass	1.0
7	Calcium (as Ca) percent by mass, Min.	1.0
8	Total phosphorus, per cent by mass, Min.	0.7
9	Available phosphorus, percent by mass, Min.	0.3
10	Vitamin A, I.U./kg, Min.	10,000
11	Vitamin D_3, I.U./kg, Min.	1500
12	Vitamin E, I.U./kg, Min.	50
13	**Aflatoxin B_1 (ppb), Max.	20
Limit/Requirement		
14	*Treated protein meals, percent by mass, Min.	25
15	Mineral mixture, percent by mass, Min.	3.0
16	Calcite powder, percent by mass, Max.	1.5
Note 1: The values for requirements (2) to (13) are on moisture-free basis. Note 2: * It should have minimum 70% rumen undegradable protein (as per*in vitro* estimation method). Note 3: **If Aflatoxin B_1 is >20 ppb, manufacturers are required to addtoxin binder at a rate specified by the suppliers. Toxin binder should be tested in NDDB's laboratory, with >90% toxin binding capacity.		

14.4 Indicative cost-benefit analysis of feeding bypass protein supplement

Two bypass protein plant, each having 20 MTPD capacity will be set up in strategic locations. Locally available protein meals will be treated with chemicals and supplied to all districts under the project area. Treated protein meal (bypass) will be fed @ 1.0 kg/animal/day by replacing 1.0 kg concentrate. Total 40,000 animals will be fed bypass protein supplement under two plants.

Garg *et al.* (2005b) estimated that through feeding bypass protein supplement, average increase in net daily income was Rs. 7-12/animal, producing 5-8 litre milk/day. For calculating cost-benefit ratio, we considered average increase Rs. 10/day/animal, and indicative cost-benefit analysis is given in Table 43.

Table 43: Indicative cost-benefit analysis for feeding bypass protein feed

Sr. No.	Cost-benefit	Unit	NR in lakhs
Expenditure			
1	Cost of Bypass protein plant Rs. 120 lakh/plant	2	240
2	Miscellaneous (labor, packing, transportation etc.)		10
	Total		**250**
Income			
1	Animals covered Average annual increase in net daily income per animal @ Rs. 10/animal/day for 365 days for 40000 animals	40000	**1460**
	Cost-benefit analysis		**5.84 times**

Summary

Protein meals have usually high rumen degradability, thus, these supplements are not able to provide adequate quantity of essential amino acids at intestinal level to meet various production needs. However, chemical treatment of protein meals to get 70-75 per cent rumen protein protection can help achieving this. The feeding trials carried out with bypass protein feed clearly indicate that farmers feeding bypass protein feed can earn some 10% more money in case of cows and about 15% in case of buffaloes.

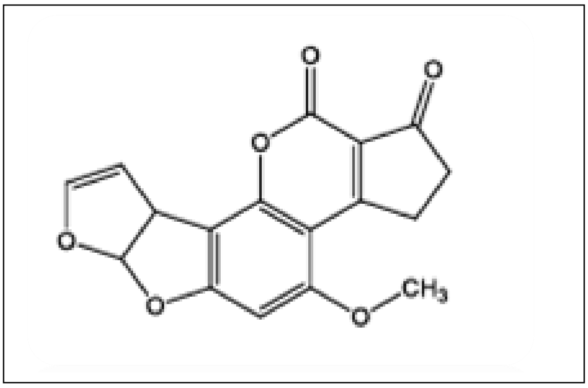
Chapter 15
Development of a Broad Spectrum Toxin Binder

Milk is highly nutritious and a complete food, being rich in macro and micro-nutrients for growth and development. Since milk is consumed by all ages, more so the most vulnerable infants and children, it is apt that proactive measures are taken to make it safe. Developments in the analytical abilities are throwing up insight into the emerging contaminants every often, and Alfatoxins are one such example. Aflatoxins are a group of mycotoxins that pose hazards to human health owing to their carry-over from feed to milk. The contamination of milk with Aflatoxin M_1 is a worldwide concern, more in developing countries. Use of mycotoxin binders to contaminated diets has been considered as the most promising dietary approach to reduce the level of M1 in milk. Under the NLSIP, an appropriate, cost effective broad spectrum mycotoxin binder - suitable for agro-climatic conditions of Nepal will be developed.

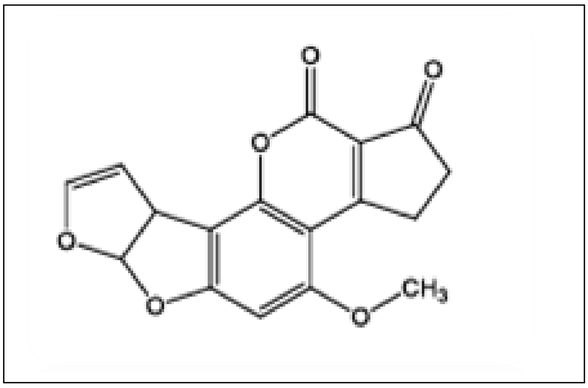
Introduction

Aflatoxins are a major class of mycotoxins produced primarily by *Aspergillus* species including *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nomius* (Creppy, 2002). These organisms invade crops and grow on foods during storage if temperature and humidity levels are favourable. The relative proportions and amounts of the various Aflatoxins on food crops depend on the *Aspergillus* species present, pest infestation, growing and storage conditions, and other factors. The major aflatoxins produced in feed stuffs are B1, B2, G1, G2 and in milk M1 and M2. Both *A. flavus* and *A. parasiticus* produce Aflatoxins B1 and B2, and *A. parasiticus* also produces aflatoxins G1 and G2 in addition to B1 and B2. Aflatoxin B1 is the most toxic, carcinogenic, teratogenic and mutagenic class of AFs (Iqbal *et al.*, 2010) and is listed as a group I carcinogen by the International Agency for Research on Cancer (IARC, 2002; Iqbal*et al.* 2014).

Aflatoxins are metabolized in ruminants by the liver and excreted in the bile. Aflatoxin M1 is a hydroxylated metabolite of B1 that is excreted in milk in the mammary glands of lactating animals. Approximately 0.3-6.2% of Aflatoxin B1 is converted into metabolized Aflatoxin M1 and excreted in milk, depending on factors such as the genetics of the animals, seasonal variation, the milking process and the environmental conditions.



Aflatoxin B1



Aflatoxin M1

To meet the limit of Aflatoxin M1 in milk, at specified level of 0.5 ppb, the feed should contain no more than 20 ppb of Aflatoxin B1. It must be noted that the occurrence of Aflatoxin M1 in milk is directly related to feed quality. Therefore, most effective way of controlling Aflatoxin M1 in milk is by reducing contamination of feedstuffs by Aflatoxin B_1 using cost effective, appropriate broad spectrum toxin binder. Maximum Residual Limits of Aflatoxin for US FDA, EU and FSSAI is given in Table 44. Similar to the FSSAI MRL limit in India, Nepal should also adhere to the same specified limit for Aflatoxin B1 and M1.

Table 44: Maximum Residual Limits (MRL) of Aflatoxin

Aflatoxin MRL	Aflatoxin (ppb)
US FDA MRL for Aflatoxin B1 in dairy feed	20
US FDA MRL for Aflatoxin M1 in milk	0.5
FSSAI MRL for Aflatoxin M1 in milk	0.5
EU MRL for Aflatoxin M1 in milk	0.05
BIS, US FDA, EU MRL for Aflatoxin B1 in poultry feed	20

15.1 Effect of Aflatoxin B1 on animal health

Aflatoxin B1 is the most potent mycotoxin. This type of toxin increases the apparent protein requirement of cattle and is a potent cancer causing agent (carcinogen). When significant amounts of Aflatoxin B1 are consumed, the metabolite M1 appears in the milk within 12 hours. Hepatotoxicity, immunosuppression, carcinogenicity and nephrotoxicity are the major effects of aflatoxins.

Aflatoxin interferes with disease resistance and vaccine-induced immunity in livestock. Symptoms of acute aflatoxicosis in mammals include in appetence, lethargy, ataxia, rough hair coat, and enlarged pale fatty livers. In contrast, chronic aflatoxicosis exhibits symptoms including reduced feed efficiency and milk production, icterus, and decreased appetite. Reduced growth rate is possibly the most obvious indication for chronic aflatoxicosis and is related to disturbances in protein, carbohydrate and lipid metabolism. The toxin becomes stable once formed in grain, resistant to degradation during normal milling and storage.

15.2 Mycotoxin binders

The addition of mycotoxin binders to contaminated diets has been considered the most promising dietary approach to reduce effects of mycotoxins (Galvano*et al.* 2001). The theory is that the binder decontaminates mycotoxins in the feed by binding them strongly enough to prevent toxic interactions with the consuming animal and to prevent mycotoxin absorption across the digestive tract. Therefore, this approach is seen as prevention rather than therapy.

Potential absorbent materials include activated carbon, aluminosilicates (clay, bentonite, montmorillonite, zeolite, phyllosilicates, etc.), complex indigestible carbohydrates (cellulose, polysaccharides in the cell walls of yeast and bacteria such as glucomannans, peptidoglycans, and others), and synthetic polymers such as cholestryamine and polyvinylpyrrolidone and derivatives.

Considerable research has been directed at finding methods to prevent toxicity of mycotoxins. Some of the approaches have included mycotoxin separation from contaminated feeds, detoxification and inactivation. Detoxification and inactivation methods include the use of binders or sequestering agents added to feed as an approach to reduce toxicity of mycotoxins by reducing reactivity of bound mycotoxins and reducing their intestinal absorption. Substances used as mycotoxin binders include indigestible adsorbent materials such as silicates, activated carbons, complex carbohydrates and others. The use of binders offers an approach to salvaging feeds with low levels of mycotoxins and to protecting animals from the background levels of mycotoxins that, although low in concentration, routinely occur and may cause chronic disease problems and losses in performance.

A binder product that meets all the desirable characteristics is not available, but the potential currently exists for practical judicial use of mycotoxins binders for reducing mycotoxin exposure to animals. Various materials offer the potential to bind mycotoxins in feed. Silicates bind aflatoxin and some other mycotoxins. Chemically modification of silicates can increase binding to mycotoxins such as deoxynivalenol and zearalenone. Activated carbon (charcoal) has produced variable binding results, perhaps because of differences in physical properties of the test product. Aflatoxin binding by activated charcoal has been variable, but mostly positive. Charcoal may also bind zearalenone and deoxynivalenol.

Complex indigestible carbohydrate polymers derived from yeast cell walls are shown effective in binding aflatoxin and restoring performance to animals consuming multiple mycotoxins (generally *Fusarium*produced). Bacterial cell walls also have potential to bind mycotoxins, but limited research has been conducted. Inorganic polymers such as cholestyramine and polyvinylpyrrolidone also have binding potential.

Desirable characteristics of a binder

A binder must be effective at sequestering the mycotoxins of interest. In some cases, it may be of value to bind one specific mycotoxin and in others, to bind multiple mycotoxins. A binder should significantly prevent animal toxicity. There should not be serious detrimental effects on the animal, or at least detrimental effects should not outweigh the benefits. Costs should render its use practical and profitable. Animal/product residues of mycotoxins should not increase. There should be no detrimental effects on the animal food product. Mycotoxins in feeds should not be masked such that feed contamination cannot be verified. The binder should be physically usable in commercial feed manufacturing situations. Binder use and efficacy should be verifiable.

Chapter 16

Recommendations of Part one Feed and Feeding Assissment

Following are the major recommendations that need to be implemented for improving productivity and reproductive efficiency of dairy animals in projected districts:

16.1 Implementation of Ration Balancing Program (RBP)

Under NLSIP, About 2.0 lakh milking animals will be covered under RBP over a period of 4 years (Table 45). Every year, about 50,000 animals will be covered. One module of RBP will cover 50 villages, covering about 1000 milking animals (covering 20 milking animals/village).

Table 45: Implementation of Ration Balancing Program (RBP)

Year	Number of animals to be covered	Number of villages to be covered (Approx.)
2019-20	50,000	2500
2020-21	50,000	2500
2021-22	50,000	2500
2022-23	50,000	2500
End of the Project	**2,00,000**	**10,000**

Trained Local Resource Persons (LRPs) will provide ration balancing advisory services to dairy farmers for feeding balanced ration to their animals.

16.2 Production of Mineral Mixture

For production of mineral mixture in projected districts, total four mineral mixture plants (cap. 12 MTPD of each) will be set up in strategic locations. One mineral mixture plant will able to supplement about 1.2 lakhs animals (Dose @ 100 g/day/animal). Thus, total 4.8 lakh animals will be supplemented with mineral mixture under four mineral mixture plants.

16.3 Production of Bypass Protein Feed

Two bypass protein plant (cap. 20 MTPD of each) will be set up in strategic locations. Locally available protein meals will be treated with chemicals and supplied to all districts under the project area. Treated protein meal (bypass) will be fed @ 1.0 kg/animal/day. Thus, about 40,000 animals will be fed bypass protein supplement under two plants.

16.4 Production of Urea Molasses Mineral Block:

Four UMMB plants (cap. 3 MTPD of each) will be set up at different strategic locations; and supply UMMBs to other parts of the project area.Weight of each block will be about 3.0 kg; thus, total 4000 blocks will be produced per day under the NLSIP project.

16.5 Enrichment and Densification of Crop Residues

Crop residues are not uniformly available across the country, some areas are surplus while some are deficit on regular basis. For such locations crop residues can be fortified with feed ingredients like cakes, brans, grains, molasses, hay, minerals and then densified into blocks or pellets to save on storage and transport costs. Under the project, two enrichment and densification plants will be set up in areas where there is surplus availability of straws; and supplied to the deficit areas.

In addition to the major recommendations, following aspectsmay also be considered in project districts:

- Propagating use of toxin binder for reducing the level of Aflatoxin M1 in milk.
- Implementing regulatory mechanism for monitoring of quality control of compound cattle feed and feed supplements in Nepal.
- Popularizing chaffing of fodder.
- Creating awareness about the silage and hay making.
- Popularizing use of calf starter, calf growth meal, pregnancy feed etc.
- Ensuring increasedparticipation of women at various levels.

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Annexure

Annexure 1: Livestock and poultry population in the NLSIP districts (2016-17)

Govt. State	Agro eco zone	Districts	Livestock Population with commodities						Poultry	
			Cattle	Buffalo	Yak&Chauri	Goats	Sheep	Pig	Chickens	Duck
State 1	E.Hills	Panchthar	105146	42932	1088	128258	1361	45267	369317	788
		Ilam	151075	23093	160	152490	145	26472	427326	218
		Dhankutta	95565	20666	0	169787	565	29374	696427	1561
		Udayapur	124065	99831	0	247630	695	50328	617436	2291
		Total	475851	186522	1248	698165	2766	151441	2110506	4858
	E.Tarai	Jhapa	236545	74744	0	25889	36	70974	1510487	3600
		Morang	399870	104692	0	279889	451	53578	1952285	57900
		Sunsari	294392	165717	0	233769	4701	56801	1439399	16740
		Total	930807	345153	0	539547	5188	181353	4902171	78240
Total State 1			1406658	531675	1248	1237712	7954	332794	7012677	83098
State 2	Tarai	Saptari	230978	181746	0	200916	2708	22404	1049076	29990
		Siraha	89446	92130	0	126503	1124	5263	849723	9285
		Dhanusa	139786	65583	0	229733	650	5796	577645	8447
		Total	460210	339459	0	557152	4482	33463	2476444	47722
Total State 2			689442	497172	0	913388	6256	44522	3903812	65454
State 3	Hills	Kavrepalanchok	144389	135256	0	301882	3802	15934	1818946	3560
		Kathmandu	46504	32848	0	44035	1532	28482	583613	4750
		Makwanpur	125138	107711	0	294024	54	15124	1204248	1397
		Total	316031	275815	0	639941	5388	59540	3606807	9707
	Tarai	Chitwan	73742	68809	0	213968	3900	10595	26884675	4362
		Total	73742	68809	0	213968	3900	10595	26884675	4362
Total State 3			389773	344624	0	853909	9288	70135	30491482	14069
State 4	Mountain	Manag	3197	0	3473	6418	5739	191	1029	17
		Mustang	7769	189	6104	35939	6808	44	13997	0

Govt. State	Agro eco zone	Districts	Livestock Population with commodities						Poultry	
			Cattle	Buffalo	Yak&Chauri	Goats	Sheep	Pig	Chickens	Duck
		Total	10966	189	9577	42357	12547	235	15026	17
	Hills	Tanahun	95296	119294	0	196676	823	9274	529519	1265
		Kaski	40328	150327	655	112089	19439	14647	2686098	11899
		Shyanja	39621	93432	0	208651	2388	21516	548691	6280
		Myadi	38970	30192	338	81559	22145	1111	202115	1058
		Total	214215	393245	993	598975	44795	46548	3966423	20502
	Tarai	Nawalpur*	68810	48127	0	123125	4816	8124	1190374	13058
		Total	68810	48127	0	123125	4816	8124	1190374	13058
Total State 4			293991	441561	10570	764457	62158	54907	5171823	33577
State 5	Hills	Argakhanchi	42396	106035	0	121965	558	2705	515702	364
		Gulmi	46590	44507	0	145040	7035	10683	313709	703
		Palpa	74386	90323	0	182400	2654	19840	558650	4258
		Total	163372	240865	0	449405	10247	33228	1388061	5325
	Tarai	Nawalparashi*	68810	48127	0	123125	4816	8124	1190374	26115
		Rupandehi	88425	142697	0	234639	4507	16296	2016985	23583
		Kapilvastu	149574	158069	0	178289	18051	5229	1070278	6032
		Bardiya	112897	117644	0	209438	12025	37213	658900	2586
		Total	419706	466537	0	745491	39399	66862	4936537	58316
Total State 5			583078	707402	0	1194896	49646	100090	6324598	63641
Grand Total (districts 28)			3362942	2522434	11818	4964362	135302	602448	52904392	259839

Source: Govn-Department of Livestock Service, Hariharbhavan, Lalitpur

Annexure 2: Cultivated green fodders in different zones of Nepal

Fodder categories	Legumes			Cereal		
	Name of the fodder	Production (mt/h)	Cultivated Zones	Name of the fodder	Production (mt/h)	Cultivated Zones
A. Annual						
1.Winter	1.Berseem (*Trifolium . alexandrium)*	100-120	Tarai – Hills	1,Oat	25-50	Terai to high hills
	2.Shaftal (*Trifolium resupinatum*	70-80	Tarai – Hills	2.		
	3.Vetch(*Vicia sativa* L)	50-60	Terai-Mid hills			
2.Summar						
	1.Joint vetch (*Aeschynomene americana*)	50-60	Tarai-Hills (Upto 1500 asl)	1.Sorgham	Tarai-hills	60-80
	2.Cowpea/Lobia (*Vigna unguiculata* L)	30-40	Tarai-Hills	2.Teosinte	Terai -hills	60-80
	3.Ricebean/Red bean (*Vigna umbellate*) (Mashyang)	30-40	Tara – Mild hills)	3.Sudan	Tarai-Midhills	50-80
	4.Guar/Cluster bean (*Cyamopsis tetragonaloba* L)	30-40	Tarai – Mid hills	4. Bajra	Tarai	50-60
	5.Glycine (*Neonotonia wightii*)	30-40	Tarai to Hills (upto 1500 nasl)	5.Fodder maize	Tarai – Hills	50-80
	6.Lablab bean (Tate Simi) (Lablab purpureus L.)	30-40	Tarai-Mid Hills (upto 1500 masl)	6. Dinanath	Tarai-Mid hills	75.0
B. Perennial						
	1. Stylo (*Stylosanthes sp*)	Tarai- Mid hills (upto 1500 masl)	50-60	1.Napier	Tarai-Hillsw	300-350
	2.Forage Peanut (*Arachis pintoi)*	Tarai-hills	50-60	2.Broom grass	Lower hills to Mountain (3000.0)	50-60
	3.Desmodium (*Desmodium uncinatum*)	Tarai – hills (1600 masl)	40-50	3.Molasses	Tarai-Hills	50-60

	4.Centro (*Centrocema molle*)	Tarai-Mid hills)	40-50	4.Paragrass		
	5.Siratro (*Macroptilium atropurpureum*)	Tarai-Mid hills)	40-50	5.Setaria	Tarai-High hills	60-80
	6.Lucern (*Medicago sativa*)	Tarai-high hills (3500)	60-80	6.Rhodes grass	----------	
				7. Guinea grass	Tarai	250-270
				8. Anjan	Tarai	30-50
				9.Marvel		
				10.Mulato	Tarai-Mid hills	50-60
				11. Blue Panic	Tarai-Mid hills	30-50
				12.Guatemala	Tarai-Mid hills	80-100
C. Alpine Pasture						
	1.White clover (*Trifolium repens*)	High hill - Mountain	30-40	1.Ryegrass (*Lolium perenne*)	High mountain	50-60
	2. Red Clover (Trifolium pretense)	High hill Mountain	50-60	2.Italian Ryegrass	High mountain	50-60
Project are also covers the districts with rangelands and therefore range crops are also been included in the review.				3.Cocksfoott*(Da cctylis glomerata)*	High mountain	50-60
				4.Paspalum (*Paspalum dilatatum*)	Mountain	30-40
				5.Kikuyu (Pennisetu*m clandestinum*)	Mountain	

Reference: Publications from (1) National Pasture and Animal Nutrition Center (2) Animal Nutrition and Feeding by CR Upreti et al 2018.

Annexure 3: Major selected top fodder trees species in the project districts and reason for selection in the project districts

Rank	Scientific Name	Common Name	Reasons for selecting fodder tree species by the farmers (survey results)*
1	*Artocarpus lakoocha Rox.*	Badahar	(1)Increased both milk and fat production (2) High biomass production with higher DM content (3) Higher nutrient contents (4) Safe to feed ruminants i.e. low nitrate and polyphenolicks. (5) Available in wide range of elevation. (6) Suitable for Tarai and hills of the project districts. USKA (USKA = Udayapur, Siraha, Kapilvastu, Argakhanchi))
2	*Ficus infectoria Roxb.* *Ficus lacor Buch.*	Kabro (Kalo) Kabro (Seto)	(1) High biomass production (2) Moderate in nutrient contents with higher DM content (3) Safe to feed ruminants i.e. low nitrate and polyphenolicks (4) Long life up to 100 years. (5) Suitable for hills of project districts.
3	*Quercus semecarpifolia Sm.*	Khasru	(1) High biomass production with higher DM content (2) Safe to feed ruminants i.e. low nitrate and polyphenolics (tannin) (3) Available for longer duration during winter (preferred by mountain people). (4) Widely available at higher altitude like upper part of Argakhanchi and Udayapur of the NLSIP project districts)
4	*Litsea polyantha Juss.*	Kutmiro	(1) Moderate in foliage yield with high DM content (2) Safe to feed ruminants i.e. low nitrate and polyphenolicks (tannin) (3) fodder available for hard time (i.e. Dukha Ko Ghans). (4) Suitable for mid hills of the project districts.
5	*Grewia tiliaefolia Vahl.*	Syal fusro	(1) Moderate in biomass production with high DM content (2) Moderate in nutrient contents (CP) but high in fat content (3) Can be harvested early in winter and goes up to March (4) Safe to feed ruminants i.e. low nitrate and polyphenolicks (5) Higher NDF with lower ADF.
6	*Ficus clavata Wall.*	Gedilo	(1)Moderate in terms of biomass production but high DM (2) high DM production (3) high CP content. (4) Fodder is available in early autumn (5) Safe to feed as the tree is moderate in nitrate content low tannin content.Suitable for hills of CCA project districts.
7	*Ficus cunia Buch.*	Khanyu	(1) The tree is moderate in biomass production (2) Khanyu produces high DM content (3) The crops records moderate in CP content (4) Tree can be lopped during hard winter (5) Fodder is safe to feed to ruminant (nitrate score of 1.455) (6) Suitable for hills of project districts.

Rank	Scientific Name	Common Name	Reasons for selecting fodder tree species by the farmers (survey results)*
8	*Quercus glauca Thunv.*	Falant	(1) Falant is low in biomass production but available before the rainy season for at least for 4 months when green fodder is yet to be ready for harvest.(2) Nitrate content is high (score 3) but still safe to feed to ruminant. (4) Suitable for high hills and mountain of project districts.
9	*Premna bengalensis Clarke.* *Premna latifolia Roxb.*	Ginderi (Kalo) Ginderi (Seto)	(1) Ginderi is moderate in biomass productionbut high in protein content (18.7%).(2) Ginderi is safe to feed as it contain 2 score in nitrate. (3) Lopping can be done for longer period (Oct to March) (4) Ginderi as sole diet can have bad smell but if fed as supplement it is safe for ruminant feeding.(5) suitable for hills of the project district(USKA = Udayapur, Siraha, Kapilvastu, Argakhanchi)
10	*Ficus roxburghii Wall.*	Nimaro	(1)Nimaro is moderate in biomass yield (DM) but it is multipurpose foddere tree, Leaves can be used for local ceremony as leaf plate i.e. Bhoj Pat. (2) This fodder is low in CP content (11.95%) but available during hard winter (December to April). (3) Fodder recorded low in tannin (2.60%) and high score on nitrate level (score 2) indicating safe feeding.
11	*Michelia champaca L.*	Champ	(1)High in fodder biomass production (28.00 kg/tree/lopping) but high in CP content (16%). (2) Fodder is safe to feed to the animal as it contains low tannin (0.05%) with moderate score for nitrate (score 2). (3) Available in early winter (October) and last for longer period (upto June).
12	*Leucaena leucocephala*	Ipil ipil	(1)Biomass yield per tree production is low but annual tonnage per hectare is high. (2) Can be lopped in every 2 months interval and available throughout the year. (3) Very high in CP (22.23%) low in tannin (0.60%) with safe score of nitrate (Score 2). (4) The best fodder to feed ruminant as supplementary feed. Cannot be feed as sole diet as it contain mimosine. (5) Need to select insect resistant species as it is attachedby insects.
13	*Ficus hispida L.*	Khasreto	(1) Moderate in biomass production but rich in protein content (16.47%) (2) Very safe to feed animal as it contain low tannin (1.7%) and very safe for feeding score for nitrate (Score 1).

Rank	Scientific Name	Common Name	Reasons for selecting fodder tree species by the farmers (survey results)*
			(3) Fodder can be lopped during early winter (December to April). (4) The crop is liked by the farmers.
14	*Morus alba L.*	Mulberry (Kimbu)	(1) Fodder tree is low in foliage yield but contain high level of protein (18.93%). (2) Available during early winter (Nov to March) (3) Safe to ruminant feeding with low nitrate content (score 2).(4) The foliage is liked by goats.
15	*Ficus religiosa L.*	Pipal	(1) A religious fodder tree and liked by the people (2) High in fodder yield (27.152 kg with medium sized tree) but yield can be up to 100 kg DM if the trees are old enough and not lopped regularly. (3) Safe to feed as score is low for nitrate (Score 2).
16	*Ficus glaberrima Bl.*	Pakhuri	(1) High in bio mass production (32.4kgDM/tree). Yield can go more than 150 kg from old trees if not regularly lopped. This is one of the biggest fodder tree species among the fodder tree in Nepal. (2) Fodder is not nutritious (CP (11.97%) but low in tannin (1.67%) with good nitrate score (Score 1). But farmers expressed that it has high digestibility and therefore good to feed to the calves. The tree species is mainly available in Gandaki river basin and adjacent area. Farmers expressed that the crop is not in favor to increase milk production. (3) Tree can be lopped for longer period and this is the benefit to manage the feeding during scare period.
17	*Melia azedarach L.*	Bakaino	(1) Bakaino is moderate in tree foliage yield per tree per year (16.65 kg DM) but very good in CP content (24.02%). (2) Safe to feed to the ruminant with 2 score for nitrate and moderate in tannin content (2.0%). (3) Fodder is very good for sheep and goats feeding. (4) Fodder is available during pre-monsoon (April to July) when green forage is still not in full production. (5) This is a multipurpose tree (i.e. good for timber).
18	*Garuga pinnata Roxb.*	Dabdabe	(1)Dabdabe is moderate in foliage production and moderate in CP content (15.16%). (2)Tree foliage is available during hard winter. (February to April) and therefore can be used as supplementary feeding to the animal.

Rank	Scientific Name	Common Name	Reasons for selecting fodder tree species by the farmers (survey results)*
			(3) Tree foliage is safe to feed to the ruminant as it contain low tannin (1.67%) and low nitrate level (Score 2).
19	*Bauhinia purpurea*	Tanki	(1)Tanki is very popular multipurpose fodder tree and produce moderate amount of tree foliage (20.0 kg DM) during winter. (2) Available during early winter (Oct to February) (3) Palatable tree foliage with high CP (17.21). (3) Feed is safe to feed as tree foliage is low in tannin (1.10%).and good nitrate (Score of 2). (4) In some places the tree is very fast growing like in Tanahun

Note Ref. Ranking of fodder trees is mainly based on the farmer's choice, and the criteria as shown in Table 5.3 (2) CCAA Climate Change Adaptation in Agriculture, Udyapur, Siraha, Kapilvastu and Argakhanchi (GCP/NEP/070/LDF).

Annexure 4: Main Livestock Feeding Systems of small and large ruminants

Annex 4.1. Livestock species and type: Dairy cattle and buffalo, **Agro-ecological zone**: Mountain**Region**: Eastern Development Region(EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Crop residues: Maize husk Paddy straw Millet straw White clover Rye grass Buki *(Anaphalis)* *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis,* and *Sauraria sp.*)	Crop residues: Maize stover Maize Husk Paddy straw Wheat straw White clover Rye grass *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut and *Sauraria sp.*)	Crop residues: Maize stover Maize husk Paddy straw Wheat straw White clover Rye grass *Supplemented with domestic brewers cot + legume hulls + roots and wild tubers as non conventional feeds + occasional salt feeding* (90:8:1:1)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with vegetable crop residues with occasional salt feeding* (95:4:1); feeds heavily dominated by residues and locally made hay + fodder trees- chestnut and *Sauraria sp.)*	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.2 Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Crop residues: Maize husk Paddy straw Millet straw White clover Rye grass Buki *(Anaphalis)* *Artemesia sp.* *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- -chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Crop residues: Maize stover Maize Husk Paddy straw Wheat straw White clover Rye grass *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- -chestnut and *Sauraria sp.*)	Crop residues: Maize stover Maize husk Paddy straw Wheat straw White clover Rye grass *Supplemented with liquid slurp + domestic brewers cot + legume hulls + roots and wild tubers as non conventional feeds + occasional salt feeding* (86:6:2:4:1:1)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with vegetable crop residues with occasional salt feeding* (95:4:1); feeds heavily dominated by residues and locally made hay + fodder trees-chestnut and *Sauraria sp.)*	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.3. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Crop residues: Maize husk Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Crop residues: Maize stover Maize Husk Paddy straw Wheat straw White clover Rye grass *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with occasional salt feeding* (99:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut and *Sauraria sp.*)	Crop residues: Maize stover Maize husk Paddy straw Wheat straw White clover Rye grass *Supplemented with liquid slurp + domestic brewers cot + legume hulls + roots and wild tubers as non conventional feeds + occasional salt feeding* (86:6:2:4:1:1)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay *Supplemented with vegetable crop residues with occasional salt feeding* (95:4:1); feeds heavily dominated by residues and locally made hay + fodder trees- chestnut and *Sauraria sp.; Schema walichii)*	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.4. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Mountain**Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		Mixed extensive system (MES)		Mixed crop-livestock system (MCLS)		Intensive system (IPS)	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Supplemented with domestic brewers cot and occasional salt feeding* (96:2:2; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (94:4:1:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Supplemented with domestic brewers cot and occasional salt feeding* (96:2:2; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (94:4:1:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Supplemented with domestic brewers cot and occasional salt feeding* (95:3:2; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (91.5:5:2:1.5; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.5 Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Quercus sp.* *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay Local grasses and legume hay Turnip Chuto (Local radish) *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (96:2:1:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis,* and *Sauraria sp.*)	Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Quercus sp.* *Supplemented with domestic brewers cot and occasional salt feeding* (98:1:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay Local grasses and legume hay Turnip Chuto (Local radish) *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (96:2:1:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis,* and *Sauraria sp.*)	Crop residues: Maize stover and dried maize stalks Maize husks Potato peels Buckwheat straw Paddy straw Millet straw White clover Rye grass *Kote (Pennisetum sp.)* *Dhimsi (Medicago Sp.)* *Brachiaria Sp.* Buki *(Anaphalis)* *Cyanodon* and other local grasses and shrubs *Quercus sp.* *Supplemented with domestic brewers cot and occasional salt feeding* (96:3:1; feeds heavily dominated by residues and seasonal forages)	Crop residues: Potato hulls Wheat straw Naked barley Buckwheat straw Furcha *(Elymus nutans)* hay Local grasses and legume hay Turnip Chuto (Local radish) *Supplemented with liquid slurp + wild tubers, colocasia leaves + occasional salt feeding* (96:2:1:1; feeds heavily dominated by residues and locally made hay + fodder trees- - chestnut, *Alnus nepalensis*, and *Sauraria sp.*)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.6. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses (Imperata, Dub grass) (7%) Forest forages Fodder from community forest (Amriso) (23%) Improved forages (Napier, Mulato, Para grass etc.) (5%) Natural grazing (65%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (20%) Improved forages (Oat, Vetch etc.) (30%) Local forages hay, straws and other crop residues (40) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (10%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (90%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (4%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (4%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.7. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses (Imperata, Dub grass) (7%) Forest forages Fodder from community forest (Amriso) (23%) Improved forages (Napier, Mulato, Para grass etc.) (5%) Natural grazing (65%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (20%) Improved forages (Oat, Vetch etc.) (30%) Local forages hay, straws and other crop residues (40) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (10%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (90%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (4%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (4%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.8. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses (Imperata, Dub grass) (7%) Forest forages Fodder from community forest (Amriso) (23%) Improved forages (Napier, Mulato, Para grass etc.) (5%) Natural grazing (65%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (20%) Improved forages (Oat, Vetch etc.) (30%) Local forages hay, straws and other crop residues (40) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (10%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (90%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (4%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (4%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.9. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses (Imperata, Dub grass) (7%) Forest forages Fodder from community forest (Amriso) (23%) Improved forages (Napier, Mulato, Para grass etc.) (5%) Natural grazing (65%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (20%) Improved forages (Oat, Vetch etc.) (30%) Local forages hay, straws and other crop residues (40) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (10%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (90%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (4%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (4%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso, Napier) 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso, Napier) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso, Napier) Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.10. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses (Imperata, Dub grass) (7%) Forest forages Fodder from community forest (Amriso) (23%) Improved forages (Napier, Mulato, Para grass etc.) (5%) Natural grazing (65%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (20%) Improved forages (Oat, Vetch etc.) (30%) Local forages hay, straws and other crop residues (40) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (10%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (90%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (4%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (4%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Napier) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Napier) Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.11. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest forages (80%) Crop residues: Legume hulls, Lentil's chuni, Sugarcane tops (10%) Supplementary feeds: Homemade concentrates including rice polish and added salts (10%)	Natural grasses and shrubs Forest forages (85) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Improved forages (Napier, Mulato) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat, Naked barley (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	Commercial feeds (10%) *Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes Agro-industrial/ Brewery by-product (15%) Mineral & feed supplements (5%)	Commercial feeds (8%) *Crop residues* Garden pea Wheat straw (72%) *Agro by-products:* Molasses Rice bran Oilseed cakes (15%) Mineral & feed supplements (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

4.12. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest forages (80%) Crop residues: Legume hulls, Lentil's chuni, Sugarcane tops (10%) Supplementary feeds: Homemade concentrates including rice polish and added salts (10%)	Natural grasses and shrubs Forest forages (85) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Improved forages (Napier, Mulato) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat, Naked barley (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	Commercial feeds (10%) *Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes Agro-industrial/ Brewery by-product (15%) Mineral & feed supplements (5%)	Commercial feeds (8%) *Crop residues* Garden pea Wheat straw (72%) *Agro by-products:* Molasses Rice bran Oilseed cakes (15%) Mineral & feed supplements (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 13.. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest forages (80%) Crop residues: Legume hulls, Lentil's chuni, Sugarcane tops (10%) Supplementary feeds: Homemade concentrates including rice polish and added salts (10%)	Natural grasses and shrubs Forest forages (85) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Improved forages (Napier, Mulato) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat, Naked barley (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	Commercial feeds (10%) *Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes Agro-industrial/ Brewery by-product (15%) Mineral & feed supplements (5%)	Commercial feeds (8%) *Crop residues* Garden pea Wheat straw (72%) *Agro by-products:* Molasses Rice bran Oilseed cakes (15%) Mineral & feed supplements (5%)

Annex 14. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest forages (80%) Crop residues: Legume hulls, Lentil's chuni, Sugarcane tops (10%) Supplementary feeds: Homemade concentrates including rice polish and added salts (10%)	Natural grasses and shrubs Forest forages (85) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Improved forages (Napier, Mulato) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat, Naked barley (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	Commercial feeds (10%) *Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes Agro-industrial/ Brewery by-product (15%) Mineral & feed supplements (5%)	Commercial feeds (8%) *Crop residues* Garden pea Wheat straw (72%) *Agro by-products:* Molasses Rice bran Oilseed cakes (15%) Mineral & feed supplements (5%)

Annex 15. Livestock species and type: Dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest forages (80%) Crop residues: Legume hulls, Lentil's chuni, Sugarcane tops (10%) Supplementary feeds: Homemade concentrates including rice polish and added salts (10%)	Natural grasses and shrubs Forest forages (85) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Improved forages (Napier, Mulato) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Vetch, Berseem, Oat) (5%) Crop residues including sugarcane tops, local legume forages (10%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	*Crop residues:* Wheat, Naked barley (75%) *Agro by-products:* Molasses Rice bran Agro-industrial/ Brewery by-product (15%) Kitchen wastes (5%) Supplementary feeds including minerals and salts (5%)	Commercial feeds (10%) *Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes Agro-industrial/ Brewery by-product (15%) Mineral & feed supplements (5%)	Commercial feeds (8%) *Crop residues* Garden pea Wheat straw (72%) *Agro by-products:* Molasses Rice bran Oilseed cakes (15%) Mineral & feed supplements (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 16. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Extensive grazing (74%) Crop residues: Maize stover Millet straw (20%) White clover and other improved grasses (5%) Supplemented with salt (1%)	Extensive grazing (60%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (39%) Supplemented with salt (1%)	Grazing (55%) Crop residues: Maize stover Maize hulls Paddy straw (40%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (45%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (54%) Supplemented with salt (1%)	Grazing (40%) Crop residues: Maize stover Maize hulls Paddy straw (55%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (35%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (64%) Supplemented with salt (1%)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 17. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Extensive grazing (74%) Crop residues: Maize stover Millet straw (20%) White clover and other improved grasses (5%) Supplemented with salt (1%)	Extensive grazing (60%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (39%) Supplemented with salt (1%)	Grazing (55%) Crop residues: Maize stover Maize hulls Paddy straw (40%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (45%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (54%) Supplemented with salt (1%)	Grazing (40%) Crop residues: Maize stover Maize hulls Paddy straw (55%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (35%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (64%) Supplemented with salt (1%)	Not Applicable	Not Applicable

Source: Upreti (2012)

Annex 18. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Extensive grazing (74%) Crop residues: Maize stover Millet straw (20%) White clover and other improved grasses (5%) Supplemented with salt (1%)	Extensive grazing (60%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (39%) Supplemented with salt (1%)	Grazing (55%) Crop residues: Maize stover Maize hulls Paddy straw (40%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (45%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (54%) Supplemented with salt (1%)	Grazing (40%) Crop residues: Maize stover Maize hulls Paddy straw (55%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (35%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (64%) Supplemented with salt (1%)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 19. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Extensive grazing (74%) Crop residues: Maize stover Millet straw (20%) White clover and other improved grasses (5%) Supplemented with salt (1%)	Extensive grazing (60%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (39%) Supplemented with salt (1%)	Grazing (55%) Crop residues: Maize stover Maize hulls Paddy straw (40%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (45%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (54%) Supplemented with salt (1%)	Grazing (40%) Crop residues: Maize stover Maize hulls Paddy straw (55%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (35%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (64%) Supplemented with salt (1%)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 20. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Mountain **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Extensive grazing (74%) Crop residues: Maize stover Millet straw (20%) White clover and other improved grasses (5%) Supplemented with salt (1%)	Extensive grazing (60%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (39%) Supplemented with salt (1%)	Grazing (55%) Crop residues: Maize stover Maize hulls Paddy straw (40%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (45%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (54%) Supplemented with salt (1%)	Grazing (40%) Crop residues: Maize stover Maize hulls Paddy straw (55%) White clover and other improved grasses (4%) Supplemented with salt (1%)	Grazing (35%) Crop residues: Potato hulls Wheat straw Naked barley Buckwheat hay Furcha *(Elymus nutans)* hay (64%) Supplemented with salt (1%)	Not Applicable	Not Applicable

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.21. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (Imperata, Dub grass) (10%) Forest forages Fodder from community forest (Amriso) (20%) Improved forages (Napier, Mulato, Para grass etc.) (10%) Natural grazing (55%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (8%) Improved forages (Oat, Vetch etc.) (35%) Local forages hay, straws and other crop residues (52) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (92%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed supplements (2%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4. 22. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (Imperata, Dub grass) (10%) Forest forages Fodder from community forest (Amriso) (20%) Improved forages (Napier, Mulato, Para grass etc.) (10%) Natural grazing (55%) Supplementary feeds: Brewers cot, maize floor,	Natural grazing & Forest forages (8%) Improved forages (Oat, Vetch etc.) (35%) Local forages hay, straws and other crop residues (52) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (92%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%)

local and wild tubers and roots and salt (5%)						supplements (2%)	Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4. 23.Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (Imperata, Dub grass) (10%) Forest forages Fodder from community forest (Amriso) (20%) Improved forages (Napier, Mulato, Para grass etc.) (10%) Natural grazing (55%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	Natural grazing & Forest forages (8%) Improved forages (Oat, Vetch etc.) (35%) Local forages hay, straws and other crop residues (52) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (92%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%) Mineral & feed	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes

						supplements (2%)	(8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4. 24. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (Imperata, Dub grass) (10%) Forest forages Fodder from community forest (Amriso) (20%) Improved forages (Napier, Mulato, Para grass etc.) (10%) Natural grazing (55%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt	Natural grazing & Forest forages (8%) Improved forages (Oat, Vetch etc.) (35%) Local forages hay, straws and other crop residues (52) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (92%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran

(5%)						Mineral & feed supplements (2%)	Oilseed cakes (8%) Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4. 25. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Hill **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (Imperata, Dub grass) (10%) Forest forages Fodder from community forest (Amriso) (20%) Improved forages (Napier, Mulato, Para grass etc.) (10%) Natural grazing (55%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt	Natural grazing & Forest forages (8%) Improved forages (Oat, Vetch etc.) (35%) Local forages hay, straws and other crop residues (52) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (5%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetables-leaves & vines (92%) Improved forages (Napier, Mulato, Para grass etc.) Natural forages (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Wheat straw Naked barley (80%) Improved forages (Oat, Vetch etc.) (15%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots (3%) Salt (2%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Broken rice and bitten rice (2%) Fodder from community forest (Amriso 15%) Supplementary feeds including salts (3%)	*Crop residues:* Wheat straw Naked barley (70%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (20%)	Commercial feeds & Kitchen wastes (3%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) Vegetable-leaves & vines (82%) *Agro by-products:* Molasses Rice bran Oilseed cakes (10%) Brewery by-products (3%)	Commercial feeds Kitchen wastes Liquid slurp (4%) *Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Fodder from community forest (Amriso) *Dus* Vegetable-leaves & vines (80%) *Agro by-products:* Molasses Rice bran Oilseed cakes (8%)

(5%)						Mineral & feed supplements (2%)	Brewery by-products (2%) Mineral & feed supplements (3%) Supplementary feeds: Brewers cot, maize floor, local and wild tubers and roots and salt (3%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4. 26. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs (road side and fallow land grazing) (80%) Forest forages Sugarcane tops (20%)	Natural grasses and shrubs (road side and fallow land grazing) (70%) Forest forages + seasonal crop residues (30%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Forest forages (20%)	*Crop residues:* Wheat straw Legume hulls Rice straw Other crop residues based on seasonal availability (100%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (80%) Kitchen wastes (20%)	*Crop residues:* Wheat & rice straw + Millet straw (90%) Kitchen wastes (20%)	*Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)	*Crop residues* Garden pea Wheat straw Legume hulls vegetable leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.27. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs (road side and fallow land grazing) (80%) Forest forages Sugarcane tops (20%)	Natural grasses and shrubs (road side and fallow land grazing) (70%) Forest forages + seasonal crop residues (30%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Forest forages (20%)	*Crop residues:* Wheat straw Legume hulls Rice straw Other crop residues based on seasonal availability (100%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (80%) Kitchen wastes (20%)	*Crop residues:* Wheat & rice straw + Millet straw (90%) Kitchen wastes (20%)	*Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)	*Crop residues* Garden pea Wheat straw Legume hulls vegetable leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.28. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs (road side and fallow land grazing) (80%) Forest forages Sugarcane tops (20%)	Natural grasses and shrubs (road side and fallow land grazing) (70%) Forest forages + seasonal crop residues (30%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Forest forages (20%)	*Crop residues:* Wheat straw Legume hulls Rice straw Other crop residues based on seasonal availability (100%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (80%) Kitchen wastes (20%)	*Crop residues:* Wheat & rice straw + Millet straw (90%) Kitchen wastes (20%)	*Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)	*Crop residues* Garden pea Wheat straw Legume hulls vegetable leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.29. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs (road side and fallow land grazing) (80%) Forest forages Sugarcane tops (20%)	Natural grasses and shrubs (road side and fallow land grazing) (70%) Forest forages + seasonal crop residues (30%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Forest forages (20%)	*Crop residues:* Wheat straw Legume hulls Rice straw Other crop residues based on seasonal availability (100%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (80%) Kitchen wastes (20%)	*Crop residues:* Wheat & rice straw + Millet straw (90%) Kitchen wastes (20%)	*Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)	*Crop residues* Garden pea Wheat straw Legume hulls vegetable leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.30. Livestock species and type: Non-dairy cattle and buffalo **Agro-ecological zone**: Terai **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs (road side and fallow land grazing) (80%) Forest forages Sugarcane tops (20%)	Natural grasses and shrubs (road side and fallow land grazing) (70%) Forest forages + seasonal crop residues (30%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops (80%) Forest forages (20%)	*Crop residues:* Wheat straw Legume hulls Rice straw Other crop residues based on seasonal availability (100%)	*Crop residues:* Paddy straw Maize stover Maize hulls Finger millet Sugarcane tops Vegetables' leaves (80%) Kitchen wastes (20%)	*Crop residues:* Wheat & rice straw + Millet straw (90%) Kitchen wastes (20%)	*Crop residues* Rice straw Pulse bushes Sugarcane tops Vegetables' leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)	*Crop residues* Garden pea Wheat straw Legume hulls vegetable leaves (80%) Agro-industrial/ brewery by-products (15%) Kitchen wastes (5%)

Source: Pariyar (2008), Upreti (2006), Shrestha (1992), Upreti (2008)

Annex 4.31.Livestock species and type: Goat **Agro-ecological zone**: Mountain **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc)* (100%*)*	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc.)*(100%)	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	*Crop residues:* Maize husk Finger millet Natural grasses and shrubs Forest forages	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Not Applicable	Not Applicable

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.32. Livestock species and type: Goat **Agro-ecological zone**: Mountain **Region**: Central Development Region (CDR)

Extensive production system (EPS)		Mixed extensive system (MES)		Mixed crop-livestock system (MCLS)		Intensive system (IPS)	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc)* (100%*)*	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc.)*(100%)	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	*Crop residues:* Maize husk Finger millet Natural grasses and shrubs Forest forages	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Not Applicable	Not Applicable

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.33.Livestock species and type: Goat **Agro-ecological zone**: Mountain **Region**: Western Development Region (WDR)

Extensive production system (EPS)		Mixed extensive system (MES)		Mixed crop-livestock system (MCLS)		Intensive system (IPS)	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc)* (100%*)*	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc.)*(100%)	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	*Crop residues:* Maize husk Finger millet Natural grasses and shrubs Forest forages	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Not Applicable	Not Applicable

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annual. 4.34. Livestock species and type: Goat **Agro-ecological zone**: Mountain **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc)* (100%*)*	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc.)*(100%)	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	*Crop residues:* Maize husk Finger millet Natural grasses and shrubs Forest forages	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Not Applicable	Not Applicable

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.35.Livestock species and type: Goat **Agro-ecological zone**: Mountain **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc)* (100%*)*	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Natural grasses and shrubs Forest fodders (*Alnus, Castanopsis etc.)*(100%)	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	*Crop residues:* Maize husk Finger millet Natural grasses and shrubs Forest forages	Natural grasses and shrubs Forest forages Fodder trees such as Ficus and Quercus sp. (100%)	Not Applicable	Not Applicable

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.36. Livestock species and type: Goat **Agro-ecological zone**: Hills **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Uncultivated grasses, shrubs & tree fodders (95%) Supplemented with maize grit and salt (5%)	Natural grasses and shrubs Forest forages (90%) Supplemented with maize grit and salt (10%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (15%) Supplemented with maize grit and salt (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest forages (15%) Supplemented with maize grit and salt (5%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4. 37. Livestock species and type: Goat **Agro-ecological zone**: Hills **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Uncultivated grasses, shrubs & tree fodders (95%) Supplemented with maize grit and salt (5%)	Natural grasses and shrubs Forest forages (90%) Supplemented with maize grit and salt (10%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (15%) Supplemented with maize grit and salt (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest forages (15%) Supplemented with maize grit and salt (5%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

4.38. Livestock species and type: Goat **Agro-ecological zone**: Hills **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Uncultivated grasses, shrubs & tree fodders (95%) Supplemented with maize grit and salt (5%)	Natural grasses and shrubs Forest forages (90%) Supplemented with maize grit and salt (10%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (15%) Supplemented with maize grit and salt (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest forages (15%) Supplemented with maize grit and salt (5%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annexx 4.39.Livestock species and type: Goat **Agro-ecological zone**: Hills **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Uncultivated grasses, shrubs & tree fodders (95%) Supplemented with maize grit and salt (5%)	Natural grasses and shrubs Forest forages (90%) Supplemented with maize grit and salt (10%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (15%) Supplemented with maize grit and salt (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest forages (15%) Supplemented with maize grit and salt (5%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, maize grit and salt (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

4.40. Livestock species and type: Goat **Agro-ecological zone**: Hills **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Uncultivated grasses, shrubs & tree fodders (98%) Supplemented with salt (2%)	Natural grasses and shrubs Forest forages (92%) Supplemented salt + hay + *Chuti* (local vegetable) (8%)	Cultivated grasses & tree fodders (82%) Natural grasses and shrubs Forest fodders (16%) Supplemented salt (2%)	Cultivated grasses & tree fodders (72%) Natural grasses and shrubs Forest forages (15%) Supplemented salt + hay + *Chuti* (local vegetable) (8%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes, and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (70%) *Agro by-products:* Rice/wheat bran (10%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes and salt (10%)	*Crop residues:* Maize husk Finger millet Legume hulls (60%) *Agro by-products:* Rice/wheat bran (20%) Natural grasses and shrubs Forest forages Cultivated grasses & tree fodders (10%) Supplemented with Kitchen wastes and salt (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

4.41. Livestock species and type: Goat **Agro-ecological zone**: Terai **Region**: Eastern Development Region (EDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (8%) Road and canal side tethering (7%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (45%) Natural grasses and shrubs Forest forages (40%) Road and canal side tethering (5%) Supplemented with agro-by products (10%)	*Crop residues:* Maize husk Sugarcane tops (15%) Rice/wheat bran (10%) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues:* Maize husk Sugarcane tops Sugarcane baggage (15%) Rice/wheat bran (10) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues* Legume hulls Vegetables' leaves + Localized grazing (70%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (5%)	*Crop residues* Garden pea Vegetable leaves + Localized grazing (60%) Homemade concentrates including cereal grains and flour (30%) Kitchen wastes (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.42. Livestock species and type: Goat **Agro-ecological zone**: Terai **Region**: Central Development Region (CDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (8%) Road and canal side tethering (7%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (45%) Natural grasses and shrubs Forest forages (40%) Road and canal side tethering (5%) Supplemented with agro-by products (10%)	*Crop residues:* Maize husk Sugarcane tops (15%) Rice/wheat bran (10%) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues:* Maize husk Sugarcane tops Sugarcane baggage (15%) Rice/wheat bran (10) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues* Legume hulls Vegetables' leaves + Localized grazing (70%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (5%)	*Crop residues* Garden pea Vegetable leaves + Localized grazing (60%) Homemade concentrates including cereal grains and flour (30%) Kitchen wastes (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.43. Livestock species and type: Goat **Agro-ecological zone**: Terai **Region**: Western Development Region (WDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (8%) Road and canal side tethering (7%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (45%) Natural grasses and shrubs Forest forages (40%) Road and canal side tethering (5%) Supplemented with agro-by products (10%)	*Crop residues:* Maize husk Sugarcane tops (15%) Rice/wheat bran (10%) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues:* Maize husk Sugarcane tops Sugarcane baggage (15%) Rice/wheat bran (10) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues* Legume hulls Vegetables' leaves + Localized grazing (70%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (5%)	*Crop residues* Garden pea Vegetable leaves + Localized grazing (60%) Homemade concentrates including cereal grains and flour (30%) Kitchen wastes (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.44. Livestock species and type: Goat **Agro-ecological zone**: Terai **Region**: Mid-Western Development Region (MWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (8%) Road and canal side tethering (7%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (45%) Natural grasses and shrubs Forest forages (40%) Road and canal side tethering (5%) Supplemented with agro-by products (10%)	*Crop residues:* Maize husk Millet straw Beans hulls (15%) Rice/wheat bran (10%) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues:* Maize husk Millet straw Beans hulls (15%) Rice/wheat bran (10) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues* Legume hulls Vegetables' leaves, Millet straw Beans hulls + Localized grazing (70%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (5%)	*Crop residues* Garden pea Vegetable leaves, Millet straw Beans hulls + Localized grazing (65%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Anne 4.45 Livestock species and type: Goat **Agro-ecological zone**: Terai **Region**: Far-Western Development Region (FWDR)

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Natural grasses and shrubs Forest fodders (85%) Road and canal side tethering (10%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (80%) Natural grasses and shrubs Forest fodders (8%) Road and canal side tethering (7%) Supplemented with agro-by products (5%)	Cultivated grasses & tree fodders (45%) Natural grasses and shrubs Forest forages (40%) Road and canal side tethering (5%) Supplemented with agro-by products (10%)	*Crop residues:* Maize husk Millet straw Beans hulls (15%) Rice/wheat bran (10%) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues:* Maize husk Millet straw Beans hulls (15%) Rice/wheat bran (10) Cultivated grasses & tree fodders (25%) Natural grasses and shrubs Forest forages (40%) Kitchen wastes (10%)	*Crop residues* Legume hulls Vegetables' leaves, Millet straw Beans hulls + Localized grazing (70%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (5%)	*Crop residues* Garden pea Vegetable leaves, Millet straw Beans hulls + Localized grazing (65%) Homemade concentrates including cereal grains and flour (25%) Kitchen wastes (10%)

Source: Upreti (2008), Kolachhapati (2006), Sapkota (2007), Bhattarai (2007), Pandey (2007), Parajuli (2012)

Annex 4.46.. Livestock species and type: Sheep **Agro-ecological zone**: Mountain **Region**: All 5 Development Regions

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Grazing (Transhumance route) (90%) Supplemented with bean + maize and salt (10%)	Transhumance; low altitude en-route forest grazing (90%) Supplemented with bean + maize and salt (10%)	Grazing (Transhumance route) (90%) Supplemented with bean + maize and salt (10%)	Transhumance; low altitude en-route forest grazing (90%) Supplemented with bean + maize and salt (10%)	Grazing (Transhumance route) (90%) Supplemented with bean + maize and salt (10%)	Transhumance; low altitude en-route forest grazing (90%) Supplemented with bean + maize and salt (10%)	NA	NA

Source: Adhikari (2010), Upreti (2008)

Annex 4.47. Livestock species and type: Sheep **Agro-ecological zone**: Hills **Region**: All Development Regions

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (95%) Maize grit + salt (5%)	Natural grazing (95%) Maize grit + salt (5%)	Natural grazing (90%) Maize grit + salt (10%)	Natural grazing (90%) Maize grit + salt (10%)	Natural forage/ pasture (85%) Cowpea/pea/ berseem hay (5%) Additional homemade concentrates (5%) Kitchen waste (5%)	Natural forage/ pasture (80%) Cowpea/pea/ berseem hay (5%) Additional homemade concentrates (10%) Kitchen waste (5%)	Not Applicable	Not Applicable

Source: Adhikari (2010), Upreti (2008)

Annex 4.48. Livestock species and type: Sheep **Agro-ecological zone**: Terai **Region**: All 5 Development Regions

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Natural grazing (95%) Maize grit + salt (5%)	Natural grazing (95%) Maize grit + salt (5%)	Natural grazing (90%) Maize grit + salt (10%)	Natural grazing (90%) Maize grit + salt (10%)	Natural forage/ pasture (85%) Additional homemade concentrates (10%) Kitchen waste (5%)	Natural forage/ pasture (85%) Additional homemade concentrates (10%) Kitchen waste (5%)	Not Applicable	Not Applicable

Source: Adhikari (2010), Upreti (2008)

4.49.Livestock species and type: Horse/Asses and mules **Agro-ecological zone**: High hills & mountains **Region**: All 5 Development Regions

Extensive production system (EPS)		**Mixed extensive system (MES)**		**Mixed crop-livestock system (MCLS)**		**Intensive system (IPS)**	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Local grazing: Dub grass Legume hulls (78%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (78%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (78%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (78%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (78%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (58%) Cultivated grasses (Oats) (20%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Rice bran + Molasses Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (58%) Cultivated grasses (Oats) (20%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Rice bran + Molasses Mustard cake (20%) Salt (2%)	*Local grazing:* Dub grass Legume hulls (58%) Cultivated grasses (Oats) (20%) Maize grains Soybean pods Gram pods Oat grains Wheat grains Wheat bran Rice bran + Molasses Mustard cake (20%) Salt (2%)

Source: Upreti (2008)

*** Ruminant Livestock Production Systems**

- *Extensive production systems:* Animals raised under these systems satisfy their nutritional needs through grazing the existing vegetation.
- *Mixed extensive systems*: Largely grazing with some supplementation.
- *Mixed crop-livestock production systems:* These production systems typically involve small herd sizes, with animals either confined in limited spaces or free-roaming. Animals under these systems are fed on different feeds, largely available on-farm and primarily consisting of crops and crop residues produced and as they become available throughout the year.
- *Intensive production systems:* Intensive production systems are, in general, professionalized, using high levels of resources but also yielding high volumes of meat and milk
.

Annex 4.50.For each of the ruminant types identified above (e.g., dairy cattle, dairy buffalo, non-dairy cattle, non-dairy buffalo, sheep, goats, etc, and production system please provide an estimate of the <u>average daily amount</u> of home-made concentrate and compound feed (concentrate feed produced by the feed industry) provided to ruminant livestock in each of the three production systems listed in the table below.

Ruminant types	Mixed Extensive Systems			Mixed Crop-Livestock Systems			Intensive Systems		
	Home-made concentrate (kg/day)	Compound feed [a] (kg/day)	Total (kg/day)	Home-made concentrate (kg/day)	Compound feed [a] (kg/day)	Total (kg/day)	Home-made concentrate (kg/day)	Compound feed [a] (kg/day)	Total (kg/day)
Dairy cattle	2.25	n/a	2.25	2.75	n/a	2.75	2.75	1.75	4.50
Dairy buffalo	2.50	n/a	2.50	3.00	n/a	3.00	3.00	1.50	4.50
Non-dairy cattle	1.20	n/a	1.20	1.50	n/a	1.50	1.80	n/a	1.80
Non-dairy buffalo	1.50	n/a	1.50	1.80	n/a	1.80	2.00	n/a	2.00
Yak/Nak/Chauri	n/a	n/a	n/a	2.3	n/a	2.3	n/a	n/a	-
Sheep	n/a	n/a	n/a	0.5	n/a	0.5	0.75	n/a	0.75
Goat	n/a	n/a	n/a	0.5	n/a	0.5	0.75	n/a	0.75
Horse/Asses	1.00	0.50	1.50	1.00	0.50	1.50	1.00	0.50	1.50

Source: Upreti (2008), Kharel *et al.* (2010), Paudyal (2003/04), Yadav and Devkota (2004), Tiwari et al. (2006), Kolachhapati *et al.* (2012)

[a]Pellet or mesh form produced by feed industry.

Annex 4.51. Percent share of ingredients by weight (DM basis) for dairy cattle and buffalo

	Mixed Extensive Systems		**Mixed Crop-Livestock Systems**		**Intensive Systems**	
Ingredient	Home-made concentrate	Compound feed	Home-made concentrate	Compound feed	Home-made concentrate	Compound feed [a]
Wheat	4	n/a	5	n/a	7	9
Maize	15	n/a	18	n/a	16	21
Barley	1	n/a	2	n/a	2	4
Millet	2	n/a	3	n/a	3	6
Rice	2	n/a	2	n/a	2	3
Sorghum	1	n/a	1	n/a	1	2
Soy	7	n/a	8	n/a	8	8
Soy Meal/Cake	6	n/a	4	n/a	7	6
Cotton Meal/Cake	6	n/a	5	n/a	6	6
Oilseeds Others Meal/Cake	20	n/a	22	n/a	20	18
DDG [b]	-	n/a	-	n/a	-	-
DDGS [b]	-	n/a	-	n/a	-	-
Sesame Cake	2	n/a	2	n/a	2	2
Fishmeal	-	n/a	-	n/a	-	
Molasses	5	n/a	4	n/a	5	3
Cereal Brans	2	n/a	2	n/a	2	5
Pulses	7	n/a	7	n/a	7	3
Cassava	2	n/a	2	n/a	2	4
Kitchen waste	18	n/a	13	n/a	10	-
TOTAL **(%)**	**100 (%)**	**100 (%)**	**100 (%)**	**100 (%)**	**100 (%)**	**100 (%)**

Source: Tiwari et al. (2006), Upreti (2008), and Bhattarai (2012)

Annexure 5: Calculation of total feed requirement (kg/d) for each category of ruminant livestock species based on total livestock population their proportion in each farming system and feed requirement (kg/d/animal)

Livestock species	Total Population under			Total feed requirement								
	Mixed-extensive	Mixed crop livestock	Intensive	Mixed Extensive System			Crop-Livestock System			Intensive system		
				Home-made concentrate	Compound	Total	Home-made concentrate	Compound	Total	Home-made concentrate	Compound	Total
Dairy cattle	124870	684289	136857	280958	n/a	280958.3	1881797	n/a	1881797	376359	239501	615860
Dairy buffalo	196993	965001	95834	492483	n/a	492483.7	2895005	n/a	2895005	287504	143752	431256
Non-dairy cattle	2261045	3110498	218609	2713254	n/a	2713254	4665748	n/a	4665748	393496	n/a	393496
Non-dairy buffalo	1463809	1748966	114063	2195714	n/a	2195714	3148140	n/a	3148140	228126	n/a	228126
Yak/Nak/Cha uri	19997	8419	1052	n/a	n/a	n/a	19365.54	n/a	19365.54	n/a	n/a	n/a
Sheep	242180	121090	20181	n/a	n/a	n/a	60545.03	n/a	60545.03	15136	n/a	15136
Goat	903731	523212	0	n/a	n/a	n/a	261606.3	n/a	261606.3	0	n/a	0
Horse/Asses	6187	3712	0	6187.5	3093.7	9281.25	3712.5	1856.25	5568.75	0	0	0

Source: Statistical year book (2012)

Annexure 6: Nutrient requirements for different physiological stages of cattle & buffaloes

Annexure . 6.1: Energy and protein requirement for different

Purpose	**Stage of Animal/ Production level**	**Energy**	**Protein**
Cattle			
Maintenance	Non-productive	118 kcal/lw$^{0.75}$kg	2.86 g DP/kg/lw$^{0.75}$
	Early lactation	131 kcal/lw$^{0.75}$kg	
	Mid lactation	134 kcal/lw$^{0.75}$kg	
Growth		1.145 ratio for maintenance and gain	2.86 g DP/LW kg$^{0.75}$ to 218 g (LWG)+0.663/kg (LW)-0.001142 kg (LW)^{2}
Pregnancy	7th month	30% increase in ME	21.66g DP Mcal ME
	8th month	50% increase in ME	
	9th month	80% increase in ME	
Lactation	Per kg of 4% FCM	1144 Kcal/kg FCM	55 g DP/kg 4% FCM
Buffalo			
Maintenance		125 kcal/lw$^{0.75}$kg	2.54 g DP/kg W$^{0.75}$
Growth	100-250 kg Bwt	10 kcal/g gain	0.238g DM/kg W$^{0.75}$
	250-300 kg Bwt	11 kcal/g gain	
	300 kg LW	12 kcal/g gain	
Pregnancy		Maintenance 125 kcal/lw$^{0.75}$kg	21.66 g DP/Mcal ME
Lactation	Per kg of 4% FCM	1230 kcal	3.42 g/kg LW$^{0.75}$

Source: Leomard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , DLS 2018. Guidelines to prepare Animal feed Balance Situation Pp 7 to 20. NRC, USA. NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 2: Nutrient requirement of pre-weaned calves (Native, Jersey and Holstein Friesian)

Body wt(kg)	Gain or less (kg)	Dry matter intake/required		Feed energy		Total crude protein(g)	Minerals		Vitamins	
		Kg	%	ME(Mcal)	TDN(kg)		Ca(g)	P (g)	A (1000 IU)	D (IU)
Growing dairy calves fed only milk										
15	300	0.27	1.80	1.30	0.32	66.6	3.6	2.4	0.66	99
25	300	0.45	1.80	2.14	0.54	111	6	4	1.1	165
30	350	0.52	1.73	2.49	0.63	128	7	4	1.3	200
40	400	0.63	1.57	2.98	0.75	148	8	5	1.8	280
50	500	0.76	1.52	3.61	0.91	180	9	6	2.1	330
Growing dairy calves fed mixed diet										
50	400	1.40	2.8	4.36	1.12	176	9	6	2.1	330
75	300	2.10	2.8	5.17	1.37	232	11	7	3.2	495

Source: (1) A.D. Tillman et al 1986.A guide to the feeding and nutrition of ruminant in the tropics. (2) Leomard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (3) DLS 2018. Guidelines to prepare Animal feed Balance Situation Pp 7 to 20.
(4) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 3: Nutrient requirement of replacement heifers (dairy cattle)

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P(g)	
Maintenance and growth											
100	0	2.4	2.4	1.6	3.81	1.1	178	93	4	4	5
	0.25	2.9	2.9	1.70	4.90	1.3	321	206	13	10	6
	0.5	3.1	3.1	1.95	5.99	1.7	391	262	14	11	6
	0.75	3.2	3.2	2.20	7.09	2.0	460	319	20	14	6
	1.0	3.3	3.3	2.45	8.18	2.3	527	375	26	18	7
150	0	3.3	2.2	1.6	5.25	1.6	234	127	5	5	6
	0.25	4.05	2.7	1.70	6.76	1.9	414	258	13	11	8
	0.5	4.2	2.8	1.95	8.26	2.3	513	315	14	12	9
	0.75	4.35	2.9	2.20	9.76	2.7	552	368	19	15	9
	1.0	4.5	3.0	2.45	11.26	3.1	623	428	25	18	9
200	0	4	2	1.6	6.49	1.8	299	157	6	6	8
	0.25	4.8	2.4	1.70	8.34	2.3	492	302	10	10	12
	0.5	5.6	2.8	1.95	10.20	2.8	577	358	14	13	13
	0.75	5.4	2.7	2.20	12.05	3.3	639	415	19	16	13
	1.0	5.6	2.8	2.45	13.92	3.8	707	472	23	18	13
250	0	4.75	1.9	1.6	7.62	2.1	264	185	7	7	9
	0.25	5.75	2.3	1.70	9.81	2.7	486	340	12	12	14
	0.5	6.25	2.5	1.95	11.99	3.3	564	395	13	13	14
	0.75	6.5	2.6	2.20	14.19	3.9	644	451	18	15	14
	1.0	6.5	2.6	2.45	16.32	4.5	724	507	23	18	14
	1.1	6.5	2.6	2.60	17.18	4.8	757	530	25	20	14
300	0	5.4	1.8	1.6	8.76	2.4	303	212	9	9	10
	0.25	6.6	2.2	1.70	11.23	3.1	526	368	13	13	16

	0.5	7.2	2.4	1.95	13.80	3.8	604	423	14	14	16
	0.75	7.5	2.5	2.20	16.27	4.5	717	502	17	15	16
	1.0	7.5	2.5	2.45	18.78	5.2	764	535	21	18	16
	1.1	7.2	2.4	3.05	22.11	6.1	797	558	24	20	16
350	0	5.9	1.7	1.6	9.78	2.7	340	238	10	10	12
	0.25	7.35	2.1	1.70	12.59	3.5	557	390	15	15	18
	0.5	8.05	2.3	1.95	15.39	4.3	637	446	15	15	18
	0.75	8.4	2.4	2.20	18.19	5.0	717	502	15	15	18
	1.0	8.4	2.4	2.45	20.99	5.8	797	558	18	18	18
	1.1	7.05	2.4	2.60	22.11	6.1	829	580	20	19	18
	1.2	8.4	2.4	2.75	23.24	6.4	860	602	21	20	18
400	0	6.8	1.7	1.6	10.92	3.0	377	264	11	11	13
	0.25	8.4	2.1	1.70	14.04	3.9	579	405	15	15	19
	0.5	8.8	2.2	1.95	17.16	4.7	657	460	15	15	19
	0.75	9.2	2.3	2.20	20.28	5.6	739	517	16	16	19
	1.0	9.6	2.4	2.45	23.42	6.5	819	573	18	18	19
	1.1	9.6	2.4	2.4	24.67	6.8	850	595	19	19	19
	1.2	9.2	2.3	2.3	25.27	7.0	883	618	20	19	19

Source: (1) Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines to prepare Animal Feed Balance Situation Pp 7 to 20. (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 4: Nutrient requirement of heifers in last 3 months of gestation

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A (1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P (g)	
250	0.6	6.5	2.6	1.90	12.5	3.4	579	405	18	18	22
300	0.6	7.5	2.5	1.90	14.2	3.9	614	430	18	18	23
350	0.6	8.4	2.4	1.95	16.1	4.4	650	455	19	19	25
400	0.6	9.2	2.3	1.95	17.8	4.9	671	470	19	19	27

Source: Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines to prepare Animal Feed Balance Situation Pp 7 to 20 (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

6.Table 5: Nutrient requirement of mature cows in the last 3 months of gestation

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A (1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total (g)	Dige-stible (g)	Ca(g)	P(g)	
250	0.4	5.75	2.3	1.80	10.33	2.83	341	238	9.17	9.17	10
300	0.4	6.9	2.3	1.80	12.4	3.4	409	286	11	11	12
350	0.4	7.7	2.2	1.80	13.9	3.8	444	311	12	12	19
400	0.4	8.4	2.1	1.80	15.4	4.2	480	336	14	14	21
450	0.4	9.45	2.1	1.80	16.8	4.6	514	360	15	15	23
500	0.4	10.0	2.0	1.80	18.2	5.0	546	382	15	15	24
550	0.4	11.0	2.0	1.80	19.5	5.3	579	405	16	16	26
600	0.4	11.4	1.9	1.80	20.8	5.7	629	440	17	17	27

1. Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines to prepare Animal Feed Balance Situation Pp 7 to 20 (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6.6: Nutrient requirement of lactating cows in the first 3 months of lactation

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A (1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total (g)	Dige-stible (g)	Ca(g)	P (g)	
250	-	6.25	2.5	2.15	14.0	3.8	650	455	22	22	16
300	-	7.2	2.4	2.10	15.2	4.2	686	480	23	23	17
350	-	8.05	2.3	2.05	16.4	4.5	721	505	24	24	19
400	-	8.8	2.2	2.00	17.5	4.8	557	530	25	25	21
450	-	9.45	2.1	1.95	18.6	5.1	793	555	26	26	23
500	-	10.5	2.1	1.90	19.7	5.4	821	575	27	27	24
550	-	11.0	2.0	1.85	20.7	5.7	857	600	28	28	26
600	-	12.0	2.0	1.85	21.7	5.9	886	620	28	28	27

Source: (Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines to prepare Animal Feed Balance Situation Pp 7 to 20 (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 7: Nutrient requirement of pre-weaned buffalo calves

Body wt(kg)	Gain or less(kg)	Dry matter intake		Feed energy		Total DCP (g)	Minerals		Vitamins	
		Kg	%	ME(Mcal)	TDN(kg)		Ca(g)	P (g)	A (1000 IU)	D (IU)
Growing buffalo calves fed only milk										
15	200	0.27	1.80	0.9	0.24	48	1.5	0.9	0.9	120
25	200	0.45	1.80	1.5	0.40	80	2.0	1.5	1.5	200
30	300	0.52	1.73	1.7	0.50	90	3.0	2.0	1.5	250
40	300	0.63	1.57	2.4	0.80	125	3.5	1.5	1.7	250
50	350	0.76	1.52	3.6	1.00	150	4.0	3.0	2.0	360
Growing buffalo calves fed mixed diet										
60	450	1.2	2.0	2.9	0.8	200	6	4	3	500
70	450	1.7	2.42	4.7	1.3	220	6	5	3	500
80	450	2.0	2.5	5.3	1.5	240	7	6	3	550
90	450	2.2	2.44	6.0	1.7	260	8	6	3	550

Sources:

2. S.K. Ranjhan and N.K. Pathak (1983). Management and feeding of buffaloes.
3. A.D. Tillman et al (1986).A guide to the feeding and nutrition of ruminant in the tropic
4. Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines to prepare Animal Feed Balance Situation Pp 7 to 20
5. NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 8: Nutrient requirement of replacement heifers (dairy buffalo)

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total (g)	Dige-stible(g)	Ca(g)	P (g)	
Maintenance and growth											
100	0	2.4	2.4	1.65	3.95	1.09	163	80	4	4	5
	0.25	3.0	3.0	2.115	6.45	1.78	312	195	9	8	6
	0.5	2.8	2.8	3.05	8.95	2.47	373	254	14	11	6
	0.75	2.8	2.8	4.08	11.45	3.16	493	313	20	14	6
150	0	3.3	2.2	1.65	3.6	1.48	223	109	5	5	6
	0.25	3.9	2.6	2.00	7.86	2.17	393	242	10	9	9
	0.5	4.1	2.7	2.50	10.36	2.86	486	319	14	12	9
	0.75	3.9	2.6	3.05	12.86	8.55	548	378	17	15	9
	1.0	3.9	2.6	3.94	15.36	4.24	609	437	21	17	9
200	0	4.1	2.0	1.65	6.65	1.84	288	135	6	6	8
	0.25	4.8	2.4	1.95	9.15	2.53	465	281	10	9	10
	0.5	5.1	2.6	2.30	11.65	3.22	543	341	14	13	12
	0.75	5.1	2.6	2.80	14.15	3.91	610	400	19	17	13
	1.0	4.8	2.4	3.47	16.65	4.60	682	471	23	20	13
250	0	4.8	1.9	1.65	7.86	2.17	327	160	8	8	9
	0.25	5.5	2.2	1.90	10.36	2.86	525	315	12	9	10
	0.5	5.9	2.4	2.15	12.86	3.55	604	374	15	12	12
	0.75	6.1	2.4	2.50	15.36	4.24	677	433	19	14	14

	1.0	5.6	2.2	3.05	17.86	4.93	732	493	22	14	14
300	0	5.6	1.9	1.65	9.01	2.49	377	183	9	9	10
	0.25	6.2	2.1	1.90	11.76	3.25	579	343	13	12	11
	0.5	6.8	2.3	2.15	14.51	4.01	663	402	17	16	13
	0.75	7.0	2.3	2.60	18.26	5.04	736	461	21	19	15
	1.0	6.5	2.2	3.05	20.01	5.52	790	521	26	23	16
350	0	6.4	1.8	1.65	10.11	2.79	426	205	10	10	12
	0.25	7.1	2.0	1.90	13.11	3.62	620	357	13	12	13
	0.5	7.6	2.2	2.15	16.11	4.45	703	416	17	15	15
	0.75	7.8	2.2	2.45	19.11	5.28	776	475	20	18	17
	1.0	7.2	2.1	3.05	22.11	6.11	826	535	23	21	18
400	0	7.0	1.8	1.65	11.17	3.09	469	227	11	11	13
	0.25	7.7	1.9	1.85	14.42	3.98	653	369	14	13	14
	0.5	8.4	2.1	2.10	17.67	4.88	740	428	17	16	16
	0.75	8.7	2.2	2.40	20.92	5.78	818	487	20	19	18
	1.0	8.3	2.1	2.90	24.17	6.68	874	547	20	21	19
450	0	7.7	1.7	1.65	12.21	3.37	515	248	12	12	14
	0.25	8.6	1.9	1.90	15.71	4.34	675	365	14	14	15
	0.5	9.1	2.0	2.10	19.1	5.12	758	424	16	16	17
	0.75	9.5	2.1	2.40	22.71	6.27	836	482	18	18	18
	1.0	9.2	2.0	2.85	26.61	7.24	896	542	20	20	20
	1.10	8.8	2.0	3.05	27.61	7.62	911	566	21	21	20

500	0	8.3	1.7	1.65	13.21	3.65	556	268	13	13	14
	0.25	9.1	1.8	1.85	16.96	4.69	701	374	15	14	16
	0.5	9.7	1.9	2.10	20.71	5.72	796	433	16	16	18
	0.75	10.2	2.0	2.40	24.46	6.76	869	492	18	18	20
	1.0	10.4	2.1	2.80	28.21	7.79	933	552	20	20	23
	1.10	9.7	1.9	3.05	29.72	8.21	971	576	21	21	23

Source: Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines toprepare Animal Feed Balance Situation Pp 7 to 20 (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 9: Nutrient requirement of buffalo heifers in last 3 months of gestation

Body wt(kg)	Gain or less(kg)	Dry matter intake/required		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P(g)	
300	0.5	6.7	2.2	2.10	14.1	3.9	538	294	16	14	25
350	0.5	7.4	2.1	2.05	15.1	4.2	592	324	21	16	27
400	0.5	8.1	2.0	2.00	16.2	4.5	647	354	23	18	30
450	0.5	8.8	2.0	2.00	17.2	4.8	726	405	26	20	34
500	0.5	9.4	1.9	1.95	18.2	5.0	779	435	28	22	38

Source: Leonard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines toprepare Animal Feed Balance Situation Pp 7 to 20. (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 10: Nutrient requirement of mature buffalo cows in last 3 months of gestation

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P (g)	
350	0.4	7.0	2.0	1.95	13.3	3.7	564	310	20	16	26
400	0.4	8.0	2.0	1.95	15.2	4.2	644	354	23	18	30
450	0.4	8.6	1.9	1.90	16.2	4.5	720	405	26	20	34
500	0.4	9.3	1.9	1.85	17.2	4.8	776	435	29	22	38
550	0.4	9.8	1.8	1.85	18.2	5.0	832	470	24	24	42
600	0.4	10.4	1.7	1.82	19.2	5.3	889	506	26	26	46
650	0.4	11.0	1.7	1.85	20.2	5.6	944	537	28	28	50

Source: Leomard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines toprepare Animal feed Balance Situation Pp 7 to 20.(3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 11: Nutrient requirement of lactating buffalo cows (4 kg milk with 7% fat)[d]

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P (g)	
300	0.0	7.2	2.4	2.00	14.4	3.9	741	460	23	18	17
350	0.0	8.4	2.4	2.00	16.8	4.6	865	537	27	21	19
400	0.0	9.0	2.3	2.00	18.0	5.0	908	559	30	23	21
450	0.0	9.6	2.1	2.00	19.1	5.3	950	580	31	24	23
500	0.0	10.1	2.0	2.00	20.2	5.6	988	600	33	25	25
550	0.0	10.7	1.9	2.00	21.3	5.9	1028	620	34	26	27
600	0.0	11.2	1.9	2.00	22.4	6.2	1064	638	35	27	30
650	0.0	11.7	1.8	2.00	23.4	6.5	1098	659	36	28	32

Source: NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Table 6. 12: Nutrient requirement of adult non-producing buffalo

Body wt(kg)	Gain or less(kg)	Dry matter intake		Diet density (Mcal/kg)	Energy		Protein		Minerals		Vitamin A(1000 IU)
		Kg	% of LW(kg)		ME (Mcal)	TDN (kg)	Total(g)	Dige-stible (g)	Ca(g)	P (g)	
300	0.0	5.4	1.8	1.65	866	24	363	176	12	9	13
350	0.0	6.3	1.8	1.65	101	28	423	205	14	11	15
400	0.0	7.0	1.8	1.65	112	31	469	227	16	13	17
450	0.0	7.6	1.7	1.65	122	34	512	248	18	14	19
500	0.0	8.2	1.6	1.65	132	36	553	268	20	15	21
550	0.0	8.9	1.6	1.65	142	39	597	288	21	16	23
600	0.0	9.5	1.6	1.65	152	42	633	305	22	17	26
650	0.0	10.3	1.6	1.65	161	44	683	327	23	18	28

Source: Leomard C. Kearl 1982. Nutrient Requirements of Ruminants in Development Countries, NRC , (2) DLS 2018. Guidelines toprepare Animal feed Balance Situation Pp 7 to 20. (3) NRC 2001. Nutrient Requirements of Dairy Cattle (seventh Revised Edition). Pub. The National Academy of Science, USA.

Annexure 7: Nutrient content of fodder tree, shrubs and climbers in Nepal

Sr. No.	English name	Scientific Name	Looping Season	Yield kg/tree (DM)	Mean							Tannin %
					DM	OM	CP	EE	NDF	ADF	ADL	
1	Ipil-Ipil	*Laucaena leucocephala*	Aug-Jun	25	32.65	89.50	22.32	2.10	47.53	37.34	19.26	0.60
2	Kimbu	*Morua alba*	Mar-Sep	25-28	26.79	87.25	18.93	3.80	40.79	33.33	14.96	15.10
3	Kutmiro	*Litsea monoplotea*	Oct-may	80	33.37	91.54	15.32	2.31	57.32	49.69	28.64	2.00
4	Koiralo	*Bauhinia variegate*	Mar-Oct	45	36.09	93.08	14.75	1.80	49.90	44.30	18.63	-
5	Khasru	*Quercus semicarpifolia*	Sep-Mar	60-132	38.68	93.10	12.84	1.64	50.76	42.21	14.62	4.28
6	Gidanri	*Premna integrifolia*	Sep-Mar	70	30.70	88.92	18.27	2.17	51.91	44.64	21.64	1.03
7	Tanki	*Bauhenia purpurea L.*	Oct-Feb	45	31.56	90.73	17.21	2.40	50.31	41.37	16.41	1.10
8	Thotne	*Ficua hispida*	Sep-Feb	10	28.98	83.07	14.67	1.87	45.28	36.78	12.77	2.45
9	Dabdabe	*Garuga pinnata*	Sep-Mar	65	30.17	87.85	15.16	2.43	41.37	36.22	16.27	1.67
10	Dudhilo	*Ficus neriifolia*	Nov-Mar	80-150	32.55	83.73	12.02	2.90	43.82	34.46	14.81	-
11	Nivaro	*Ficus roxburghii*	Sep-may	70	26.61	84.62	11.95	2.70	44.00	37.98	15.15	2.60
12	Pakhuri	*Ficus globerrima*	Sep-may	120	28.29	86.26	11.97	1.10	45.10	39.57	16.37	0.40
13	Paiyu	*Prunus serasoides*	Jan-may	23-55	34.28	92.75	15.02	3.15	40.88	31.28	14.10	0.75
14	Badahar	*Artocarpus lakoocha*	Nov-Mar	95	32.95	83.72	13.43	1.80	44.69	38.92	17.40	0.60
15	Rai Khanyu	*Ficus semicordata*	Sep-Apr	55	34.50	87.00	11.60	1.60	31.32	26.25	11,25	-

Source: (1) FAO., 2012. (2) C.R. Upreti 2018. Animal Nutrition and Fodder production 2018.

Annexure 8: Mineral content of fodder tree, shrubs and climbers in Nepal

Sr. No.	English name	Scientific Name	Mean								
			Ca (%)	**P (%)**	**Mg mmol/kg**	**Na mmol/kg**	**K (%)**	**Cu (mg/kg)**	**Fe (mg/kg)**	**Mn (mg/kg)**	**Zn (mg/kg)**
1	Ipil-Ipil	*Laucaena leucocephala*	2.59	0.22	3.97	26.60	1.00	11.60	109.20	66.70	19.00
2	Kutmiro	*Litsea monoplotea*	1.66	0.34	101.90	13.30	1.60	20.30	387.40	330.30	72.70
3	Koiralo	*Bauhinia variegata*	1.81	0.24	66.10	3.20	1.18	17.79	668.90	90.33	38.75
4	Kimbu	*Morua alba*	2.91	0.40	110.00	16.90	2.20	6.40	169.50	63.40	29.20
5	Khasru	*Quercus semicarpifolia*	2.03	0.30	64.31	28.50	1.98	8.53	331.20	261.50	32.83
6	Gidanri	*Premna integrifolia*	1.76	0.35	28.44	35.95	2.93	15.70	278.20	135.40	47.23
7	Tanki	*Bauhenia purpurea L.*	2.40	0.30	94.44	22.95	2.00	14.80	335.80	64.90	29.80
8	Thotne	*Ficua hispida*	2.53	0.21	168.15	29.70	3.00	10.40	252.70	253.20	31.80
9	Dabdabe	*Garuga pinnata*	2.15	0.35	103.50	16.90	3.00	16.40	408.65	161.85	55.05
10	Dudhilo	*Ficus neriifolia*	3.18	0.24	1.35	16.20	1.70	5.30	250.90	173.60	16.10
11	Nivaro	*Ficus roxburghii*	2.79	0.24	151.60	23.90	2.20	8.20	237.90	244.00	32.20
12	Pakhuri	*Ficus globerrima*	2.71	0.23	68.10	72.10	2.30	18.00	260.40	136.10	52.50
13	Paiyu	*Prunus serasoides*	1.61	0.28	66.07	4.70	2.25	9.60	290.60	346.55	19.45
14	Badahar	*Artocarpus lakoocha*	1.96	0.27	1.41	7.90	1.60	8.70	516.40	622.80	55.80
15	Rai Khanyu	*Ficus semicordata*	4.33	0.29	111.70	7.50	1.60	10.80	482.10	76.10	44.80

Source: (1) FAO., 2012. (2) C.R. Upreti 2018. Animal Nutrition and Fodder production 2018.

Annexure 9: Nutrient content (%) of local grass and legumes in Nepal

S.N.	English name	Scientific Name	Mean								
			DM	OM	CP	EE	NDF	ADF	ADL	Ca	P
1	Amriso	*Thysenolena maxima*	20.95	91.33	10.20	-	76.35	57.30	12.90	0.50	0.23
2	Kans	*Vetiveria zizanioides*	-	88.89	8.75	-	71.98	43.44	7.70	0.52	0.30
3	Kose ghans	-	-	91.73	4.37	-	68.18	63.37	9.22	-	-
4	Khar	*Themeda triandra forsk*	-	92.95	6.07	-	71.59	56.17	14.62	0.51	0.11
5	Chitre banso	*Anthraxon lancifolius*	-	89.97	7.02	-	75.10	54.07	15.88	0.59	0.45
6	Dubo	*Cynodon dactylon L.*	26.23	82.42	12.44	-	68.57	46.92	15,83	0.62	0.32
7	Dimchi	-	16.08	83.19	14.68	-	60.25	50.92	23.01	0.52	0.40
8	Punjabi	-	-	78.24	7.84	-	63.74	50.42	23.61	0.31	0.49
9	Furke	*Pittosporum napaulense(DC)*	-	93.93	5.98	-	80.25	42.68	5.01	0.24	0.30
10	Banso	*Setaria pallidesesca*	21.28	85.96	10.80	-	61.55	43.13	9.07	0.73	-
11	Sama	*Echinochloa frumentacea (Roxb)*	-	89.77	5.49	-	67.32	41.38	5.53	0.41	0.30
12	Salimo	*Chrysopogon gryllus (L)*	-	91.57	6.49	-	75.26	54.08	10.32	0.44	0.39
13	Sisnu	*Utrica dioica*	17.7	87.40	13.90	1.00	74.30	56.20	18.10	6.00	0.57

Annexure 10: Nutrient content (%) of improved grass and legumes in Nepal

S.N.	Local Name	*Scientific Name*	Mean								
			DM	OM	CP	EE	NDF	ADF	ADL	Ca	P
1	Composit	-	-	89.07	18.00	2.22	49.95	41.62	22.47	0.50	0.30
2	Kikkyu	*Pennisetum cladestinum*	-	87.26	20.32	-	57.42	37.38	8.29	0.48	0.66
3	Kudju	*Peuraria phaseoloides*	20.15	83.63	16.76	-	44.36	36.37	8.97	1.64	0.31
4	Oat grass	*Avena sativa L.*	15.74	89.13	11.65	3.35	57.37	44.12	8.43	0.46	0.34
5	Desmodium	*Desmodium spp.*	21.35	90.30	17.91	2.40	54.13	45.36	14.03	0.75	0.26
6	Napier	*Pennisetum purpureum*	17.79	84.62	8.61	-	65.12	41.96	9.68	0.66	0.36
7	Paspalum	-	19.75	89.89	16.83	-	64.80	48.35	14.06	0.54	0.44
8	Berseem	-	20.50	85.98	20.92	2.20	59.65	51.72	19.93	1.64	0.41
9	Vetch ghans	*Vicia sativa*	17.50	84.64	21.90	2.75	54.59	48.95	17.97	1.04	0.25
10	Molasses	-	21.45	92.09	9.83	1.78	73.77	58.77	13.33	0.37	0.43
11	Lablab	-	-	89.78	19.97	-	51.55	40.30	16.57	1.67	0.38
12	Stylo	-	21.45	92.12	13.37	-	60.19	51.56	12.80	1.17	3.94
13	Seteria	-	15.13	90.69	9.52	2.00	71.69	57.99	14.12	0.42	0.43
14	White clover	*Trifolium repens L.*	-	87.61	22.72	-	41.68	35.63	11.20	1.76	0.46

Annexure 11: Nutrient content (%) of feed ingredients in Nepal

S.N.	Localname	Mean						
		DM	OM	CP	EE	CF	Ca	P
1	Gahun ko geda	87.25	97.22	13.05	-	6.07	0.11	0.41
2	Gahun ko choker	88.17	93.41	12.72	2.24	9.86	0.32	0.58
3	Jai ko geda	93.11	93.26	11.40	8.20	-	0.25	0.47
4	Til ko pina	90.30	92.24	30.52	-	11.30	0.61	0.69
5	Tori ko pina	89.76	91.18	31.81	8.80	11.77	0.72	0.93
6	Dhan ko dhuto	89.07	88.64	10.37	6.81	10.60	0.24	0.71
7	Bhatamas ko geda	88.84	93.18	40.43	4.32	-	0.37	0.57
8	Bhatmas ko pina	90.12	92.43	39.43	-	6.83	1.30	0.65
9	Makai ko geda	88.87	98.06	10.19	1.35	3.81	0.16	0.42
10	Machha ko dhulo	93.96	49.45	33.26	1.90	3.23	2.91	0.94
11	Musuro ko choker	-	90.17	13.30	1.45	10.40	0.70	0.31
12	Rahari ko geda	90.20	95.48	23.18	-	10.82	0.25	0.35
13	Rahari ko choker	87.24	95.47	13.20	-	28.33	0.33	0.21
14	Suryamukhi pins	91.50	90.99	34.60	-	18.12	0.64	0.98

Source: NARC 2006. Nutrient content of feeds and fodder in Nepal, Pub, NARC Nepal.

Annexure 12: Nutrient content (%) of crop residues in Nepal

S.N.	Local Name	Scientific Name	Mean								
			DM	OM	CP	EE	NDF	ADF	ADL	Ca	P
1	Kodo ko nal	-	88.66	90.18	5.66	-	65.52	55.65	12.53	1.22	0.50
2	Gahun ko chhawali	*Triticum spp.*	89.30	93.20	3.25	2.24	80.66	69.89	13.60	0.45	0.02
3	Chana ko kunauro	-	90.27	96.00	8.57	0.93	-	-	-	0.51	0.10
4	Bhatmas ko kunauro	*Glycine n max*	41.10	92.20	7.73	-	65.22	52.08	16.20	1.12	0.11
5	Makai ko khosta	*Zea maize*	90.63	96.28	3.92	-	84.56	70.63	10.14	0.60	0.30
6	Makai ko dhod	*Gea mays L.*	89.31	95.43	4.82	0.93	78.75	48.47	5.68	-	-
7	Mas ko kusauro	-	89.48	88.08	11.30	-	67.58	58.90	3.27	1.28	1.18
8	Rice straw	*Oriza sativa*	86.64	87.90	4.17	-	69.05	49.06	9.11	-	-

Source: NARC 2006. Nutrient content of feeds and fodder in Nepal, Pub, NARC Nepal

Annexure 13: Nutrient content (%) of non-conventional feedstuffs in Nepal

S.N	Local Name	Scientific Name	DM	OM	CP	EE	NDF	ADF	ADL	Ca	P
1	Aap ko pat	*Magnifera indica*	37.03	91.15	12.78	4.87	42.57	36.19	14.66	2.12	0.10
2	Katakahar ko pat	*Artocarpus integra*	30.90	87.03	15.89	2.80	45.29	25.77	10.06	2.25	0.56
3	Kaphi ko pat	*Coffea Arabica*	37.36	88.15	10.39	2.13	54.98	43.83	23.89	0.92	0.19
4	Kaphal ko pat	*Myrica esculenta*	15.87	96.91	8.33	2.01	75.76	69.81	45.81	0.47	0.03
5	Kera ko bokra	*Musa paradisica*	29.07	86.05	12.97	8.62	36.83	29.58	26.19	0.31	0.25
6	Kera ko pat	*Musa paradisica*	20.07	87.38	15.89	6.25	66.65	59.89	11.58	0.47	0.36
7	Jalkumbhi	*Imopoea aquatic*	6.44	50.06	15.57	0.94	48.58	42.81	40.41	2.26	0.70
8	Banmara	*Eupatorium adenopho*	6.64	88.82	13.71	1.58	28.95	26.31	21.15	1.27	0.41
9	Raksi ko kat	-	16.64	96.68	17.12	1.06	43.50	41.61	38.45	0.30	0.31
10	Sakharkhand lahara	*Ipomoca batata*	9.36	77.31	10.55	0.31	80.86	71.90	8.78	0.95	0.44

Source: NARC 2006. Nutrient content of feeds and fodder in Nepal, Pub, NARC Nepal

Annex 14: Proximate and mineral composition of concentrates and roughages in India

Annex Table 14.1: Proximate composition of concentrates (on dry matter basis)

Ingredient	**CP (%)**	**EE (%)**	**CF (%)**	**NFE (%)**	**Ash (%)**	**NDF (%)**	**ADF (%)**	**Lignin (%)**	**ME (Mcal)**
Grains and seeds									
Maize	9.0	4.2	2.0	81.6	2.0	15.6	3.5	1.0	3.1
Sorghum	8.7	2.5	3.0	81.6	2.8	10.9	5.9	1.1	3.0
Wheat	11	2.6	2.0	81.5	2.4	16.0	4.0	1.2	2.9
Barley	12	2.5	5.9	79.0	2.5	20.0	7.0	2.0	2.8
Oats	11	4.4	15.5	63.3	5.0	13.8	5.0	2.9	2.6
Rice	9	1.5	10.1	72.5	8.4	12.5	4.3	1.5	2.8
Bajra	12	3.5	2.0	78.4	4.9	15.3	5.3	2.5	2.2
Black gram	29.0	1.0	5.3	62.1	5.6	17.0	2.0	7.0	2.5
Whole Cottonseed	22.0	17.3	18.0	40.0	3.7	48.0	42.7	17.45	3.3
Milling byproducts									
Wheat bran	16.0	2.2	15.0	59.9	8.4	64.0	14.5	3.6	2.7
Rice bran (de-oiled)	17.0	1.5	18.0	48.1	18.2	38.2	11.9	4.3	2.1
Rice polish	14.0	14.0	12.0	49.2	11.8	19.4	15.0	3.0	2.7
Brewer’s grain	25.4	6.5	14.9	48.4	4.8	44.0	23.0	5.5	2.4
Molasses									
Cane molasses	2.0	8.5	-	84.2	3.5	-	-	-	2.6
Plant protein concentrates									
Soybean meal	53.0	1.4	7.0	36.0	8.6	18.6	8.8	1.5	2.5
Groundnut oil cake	40.0	8.2	7.4	35.9	7.5	23.3	18.2	3.6	2.8
Groundnut meal	44.0	1.0	13.2	35.4	6.1	31.2	22.1	3.0	2.7
Cottonseed meal (decorticated)	41.0	9.2	6.3	37.8	8.2	28.0	20.0	6.0	2.8
Cottonseed meal (undecorticated)	22.8	9.2	24.1	36.6	7.3	53.9	41.2	11.5	2.5
Rapeseed meal	42.0	1.0	8.5	48.2	4.7	23.8	15.4	2.4	2.5
Rape seed cake	38.0	7.5	7.9	45.1	4.3	25.6	18.6	6.3	2.9
Sunflower meal (undecorticated)	31.0	6.7	25.3	27.2	14.0	39.9	26.9	8.2	1.9
Sesame oil cake	30.0	10.0	8.0	39.2	8.6	14.3	8.2	1.3	2.3
Coconut meal	30.0	0.5	9.0	54.5	9.0	37.6	22.2	3.1	2.3

Source: Garg, M.R., Sherasia, P.L. and Bhanderi, B.M. (2012).A book on nutritive value of commonly available feeds and fodders in India.

Annex Table 14.2: Proximate composition of roughages (on dry matter basis)

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Hay (sun-cured)								
Sorghum *(Soghum bicolor)*	7.0	1.2	38.9	47.1	8.5	56.5	40.3	1.9
Wheat *(Triticum aestivum)*	3.5	1.0	41.5	43.0	11.0	72.3	43.5	1.9
Maize *(Zea mays)*	3.6	0.8	33.2	51.9	10.5	62.2	37.4	2.1
Oats *(Avena sativa)*	5.6	1.7	35.9	48.5	8.3	58.0	36.4	2.0
Cowpea *(Vigna sinensis)*	15.0	1.1	34.8	35.5	13.3	54.0	48.0	1.8
Peanut *(Arachis hypogaea)*	10.8	3.4	33.2	44.0	8.6	45.0	36.0	2.0
Rice *(Oryza sativa)*	8.2	1.0	32.0	43.1	15.7	71.7	48.7	1.9
Soybean *(Glycine max)*	15.0	1.3	29.1	42.6	12.0	59.0	42.8	1.9
Cassava *(Manihot esculenta)*	15.4	12.2	22.8	41.1	8.5	40.2	30.7	2.5
Lucerne *(Medicago sativa)*	16	1.4	29.4	35.2	12.7	43.6	35.8	2.0
Guar *(Cyamopsis tetragonoloba)*	25.2	0.9	13.8	43.6	16.5	48.9	33.3	1.8
Moth bean *(Phaseolus aconitifolius)*	15.0	1.2	29.1	42.7	12.0	61.6	45.0	2.1
Chickpea *(Cicer arietinum)*	12.2	2.3	33.0	42.3	10.2	55.1	40.5	1.8
Berseem *(Trifolium alexandrinum)*	15	6.6	30.6	36.0	12.1	49.6	50.4	2.4
Cogon grass *(Imperata cylindrica)*	4.7	1.7	38.1	49.2	6.3	63.3	43.6	1.1
Para grass *(Brachiaria mutica)*	5.3	2.0	34.6	45.8	12.3	64.4	30.4	1.7
Guinea grass *(Panicum maximum)*	7.6	1.2	38.1	37.1	16.0	60.5	39.7	1.7
Rhodes grass *(Chloris gayana)*	9.4	1.2	36.2	42.1	11.1	72.0	39.8	2.1
Pigeon pea *(Cajanus cajan)*	9.3	2.5	29.7	49.2	9.3	78.6	60.2	2.2
Garden pea *(Pisum sativum)*	10.9	1.9	29.2	50.3	7.7	67.2	45.9	1.8
Lemon grass *(Cymbopogon citratus)*	6.6	1.0	34.3	51.9	6.2	72.6	44.1	1.9
Marvel grass *(Dichanthium annulatum)*	4.6	0.9	38.9	46.1	9.5	63.8	41.1	2.1
Rice grass *(Leersia hexandra)*	6.3	1.5	31.4	45.9	14.9	66.2	36.2	2.2
Ulla grass *(Themeda arundinacea)*	1.9	1.0	49.0	43.5	4.6	-	-	1.7
Molasses grass *(Melinis minutiflora)*	4.4	1.1	37.8	46.6	10.1	69.8	40.4	1.9
Natal grass *(Rhynchelytrum roseum)*	5.6	1.4	41.6	43.4	8.0	66.8	36.9	1.9
Bermuda grass *(Cynodon dactylon)*	8.4	1.4	20.2	58.4	11.6	71.1	38.2	1.8
Plume grass *(Erianthus ravennae)*	1.9	1.6	43.9	45.7	6.9	78.5	50.7	1.6
Pili grass *(Heteropogon contortus)*	7.0	1.4	34.5	47.9	9.2	72.1	43.1	2.0
Dal grass *(Hymenachne interrupta)*	7.5	1.4	29.3	52.6	9.2	64.7	34.4	2.0
Sain grass *(Sehima nervosum)*	4.5	1.0	24.5	61.1	8.9	73.7	44.9	1.9
Mauritian *(Apluda mutica)*	5.5	1.0	34.8	51.0	7.7	-	-	1.3
Giant reed *(Arundo donax)*	8.8	1.1	33.0	44.7	12.4	68.3	38.6	1.9
Atylosia scarabaeoides	10.0	2.0	36.0	44.5	7.5	-	-	-
Musal grass *(Iseilema laxum)*	6.4	0.6	35.6	50.6	6.8	71.1	41.9	2.0
Baib grass *(Eulaliopsis binata)*	4.1	1.6	38.3	48.3	7.7	-	-	-
Chloris polydactyla	6.0	1.4	30.9	49.8	11.9	-	-	1.7
Chrysopogon lancearius	4.7	1.2	27.6	50.2	16.3	70.4	41.1	1.7
Anjan Grass *(Cenchrus ciliaris)*	4.9	0.8	32.9	51.2	10.2	-	-	1.9
East African stargrass *(Cynodon plectostachyus)*	5.4	0.9	37.6	45.3	10.8	-	-	1.8

Feed Name	**CP (%)**	**EE (%)**	**CF (%)**	**NFE (%)**	**Ash (%)**	**NDF (%)**	**ADF (%)**	**ME (Mcal)**
Dolichos biflorus	10.6	1.8	16.2	58.3	13.1	69.8	45.2	1.7
Shama Millet *(Echinochloa colona)*	7.3	2.0	40.5	42.2	8.0	72.6	43.6	1.7
Ghiabati *(Ipomea pes trigis)*	13.6	3.5	27.0	44.0	11.9	-	-	1.8
Dropseed *(Marginatus sporobolus)*	6.1	1.0	34.3	49.8	8.8	66.4	40.6	1.4
Straws								
Wheat *(Triticum aestivum)*	3.0	1.0	35.2	50.8	10.0	74.2	49.6	1.4
Millet *(Setaria spp.)*	4.0	1.0	34.0	52.3	8.7	78.0	56.0	1.7
Proso millet *(Panicum miliaceum)*	4.5	1.2	33.1	45.9	15.3	65.8	39.9	1.5
Koda millet *(Paspalum scrobiculatum)*	2.3	1.4	34.3	49.4	12.6	69.1	41.2	1.9
Oats *(Avena sativa)*	3.4	0.9	34.9	53.3	7.5	74.2	49.6	1.6
Barley *(Hordeum vulgare)*	4.0	0.9	47.4	40.4	9.1	65.8	39.9	1.7
Rice *(Oryza sativa)*	4.6	1.5	42.2	32.1	20.6	66.2	51.6	1.4
Ragi *(Eleusine coracana)*	3.4	1.1	33.0	51.2	11.0	61.5	49.5	2.0
Peanut *(Arachis hypogaea)*	15.0	2.9	27.6	43.7	10.8	64.4	54.3	1.9
Pigeon pea *(Cajanus cajan)*	10.7	2.0	36.2	39.1	12.0	57.5	41.4	1.5
Chickpea *(Cicer arietinum)*	10.1	0.4	28.8	46.5	14.2	64.8	41.4	1.7
Dolichos biflorus	10.5	1.2	44.8	38.2	5.3	-	-	-
Pili grass *(Heteropogon contortus)*	3.2	1.5	37.4	48.2	9.7	73.7	45.0	1.8
Reed-grass *(Phragmites karka)*	3.8	1.0	29.8	49.6	15.8	-	-	-
Rottboellia exaltata	5.3	0.8	31.1	52.0	10.8	-	-	-
Schizachyrium brevifolium	4.7	1.0	26.1	56.1	12.1	-	-	-
Pasture, Range Plants and Forages Fed Fresh								
Maize *(Zea Mays)*								
Early vegetative	12.1	1.1	29.6	44.2	13.0	52.47	32.8	2.2
Late vegetative	8.2	0.9	27.2	51.9	11.8	-	-	-
Milk stage	6.4	0.9	29.9	51.2	11.6	-	-	-
Silage, milk stage	7.9	1.1	24.6	55.1	11.3	-	-	-
Oats *(Avena sativa)*								
Early vegetative	18.8	3.6	18.0	37.5	22.1	53.4	30.2	2.3
Late vegetative	14.6	2.1	32.9	36.5	13.9	-	-	-
Early bloom	10.8	1.8	31.0	46.0	10.4	-	-	-
Late bloom	9.2	1.8	34.8	44.8	9.4	-	-	-
Milk stage	6.4	2.3	28.7	53.3	9.3	-	-	-
Ripe	5.3	2.5	34.2	47.1	10.9	-	-	-
Silage, late bloom	7.3	1.6	40.8	40.6	9.7	-	-	-
Wheat (Non-irrigated)								
Early vegetative	11.2	2.6	25.2	50.4	10.6	-	-	-
Milk stage	9.3	2.3	15.3	65.4	7.4	-	-	-
Dough stage	7.3	1.3	34.7	48.0	8.7	-	-	-
Wheat (Irrigated)								
Early vegetative	23.3	3.4	21.5	40.2	11.6	58.1	29.8	2.6
Milk stage	11.8	2.0	31.6	41.7	12.9	-	-	-
Dough stage	6.4	1.4	26.3	56.2	9.7	-	-	-

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Wheat straw silage	3.5	0.5	39.4	42.0	14.6		-	1.7
Pearl millet *(Pennisetum typhoides)*								
Full bloom	2.4	1.3	37.1	48.7	10.5	64.8	34.5	2.2
Mature	2.3	1.1	36.7	49.8	10.1	-	-	
Rice *(Oryza sativa)*								
Early vegetative	7.0	1.8	25.9	47.3	18.0	-	-	1.9
Dough stage	5.8	2.2	29.5	44.2	18.3	-	-	-
Rice straw silage	5.9	1.7	30	51.0	11.4	-	-	-
Sweet clover *(Melilotus indica)*								
Early vegetative	25.3	3.0	21.2	35.9	14.6	-	-	-
Late vegetative	23.3	2.7	19.3	40.3	14.4	-	-	-
Early bloom	23.0	2.5	27.4	33.5	13.6	-	-	-
Mature	16.0	1.9	35.2	38.0	8.9	-	-	2.1
Soybean *(Glycine max)*, early vegetative	13.0	1.7	31.3	45.2	8.8	-	-	2.1
Sunflower (*Helianthus annuus)*, late vegetative	11.0	3.4	24.0	46.2	15.4	-	-	2.3
Barley *(Hordeum vulgare)*	8.4	1.9	31.8	43.4	11.4	47.7	29.3	2.2
Bluestem *(Dichanthium annulatum)*								
Early vegetative	8.8	1.2	35.0	45.1	9.9	-	-	-
Late vegetative	4.8	0.8	36.3	48.3	9.8	-	-	-
Early bloom	4.7	1.3	41.1	43.8	9.1	-	-	-
Late bloom	4.7	1.3	40.7	42.4	10.9	-	-	-
Milk stage	3.8	1.2	35.0	50.9	9.9	-	-	-
Mature stage	3.1	1.1	35.2	50.6	10.0	76.1	47.8	1.8
Guar *(Cyamopsis tetragonoloba*)								
Early vegetative	18.1	1.9	31.9	37.7	10.4	42.3	37.3	2.1
Late vegetative	12.8	1.5	29.5	49.3	6.9	48.4	42.5	-
Mature	8.6	1.7	30.0	47.0	12.7	55	47.7	-
Chick pea *(Cicer arietinum)*								
Late vegetative	11.3	2.2	27.2	47.9	11.4	-	-	2.2
Mid bloom	10.9	2.1	33.1	44.8	9.1	-	-	-
Milk stage	8.6	0.8	36.8	43.0	10.8	-	-	-
Safflower *(Carthamus tinctorius)*								
Early vegetative	17.0	1.6	10.9	58.3	12.2	-	-	-
Late vegetative	15.1	1.7	16.4	55.3	11.5	-	-	2.2
Milk stage	15.6	1.9	23.6	47.7	11.2	-	-	-
Mid bloom	12.2	2.1	25	50.4	10.3	-	-	-
Peanut *(Arachis hypogaea)*	9.8	0.7	34.1	48.1	7.3	-	-	2.4
Bluestem, Pitted *(Andropogon pertussis)*								
Late vegetative	5.4	1.2	36.5	44.6	12.3	-	-	-
Late bloom	3.9	1.1	35.7	48.0	11.3	-	-	-
Mature	3.2	1.3	36.5	47.7	11.3	-	-	-
Bluestem, Eastindies *(Andropogon*	3.9	1.5	38.5	46.0	10.1	-	-	-

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
ischaemum), mature								
Beet root *(Beta vulgaris)*, early vegetative	13.6	2.8	6.3	60.3	17.0	-	-	2.8
Tickclover *(Desmodium gyroides)*, late vegetative	11.5	0.7	45.2	34.1	8.5	-	-	-
Tickclover, silver lead *(Desmodium uncinatum)*	12.8	3.4	29.6	45.1	9.1	-	-	-
Hyacinth bean (*Dolichos lablab)*, early vegetative	16.5	13.1	25.9	34.5	10.0	44.6	34.0	2.2
Water hyacinth *(Eichhorna crassipes)*								
Early vegetative	9.8	1.5	21.6	51.2	15.9	-	-	-
Whole silage	7.3	1.2	25.4	45.8	20.3	-	-	-
Koda millet *(Paspalum scrobiculatum)*								
Early vegetative	11.4	1.4	28.8	44.1	14.3	68.8	39.2	2.0
Early bloom	6.7	1.2	36.5	43.7	11.9	-	-	-
Dough stage	5.7	1.5	31.6	49.1	12.1	-	-	-
Sorghum *(Sorghum bicolor)* Silage	5.9	1.8	37.3	44.4	10.6	65.9	42.3	2.1
Fenugreek (*Trigonella foenum graecum)*, early vegetative	15.7	2.1	13.1	60.3	8.8	-	-	2.1
Berseem (*Trifolium alexandrinum)*	17.4	1.9	25.9	40.6	14.2	42.4	30.5	2.3
Cowpea *(Vigna sinensis)*, mature	25.5	2.6	25.3	32.4	14.2	46.3	31.2	2.3
Fresh	15.4	1.2	32.3	49.9	1.2	64.4	30.6	-
Early vegetative	12.0	2.9	28.2	45.1	11.2	-	-	-
Early bloom	6.9	0.8	35.4	46.1	10.8	-	-	-
Rhodes grass *(Chloris gayana)*								
Early vegetative	11.9	1.5	33.5	43.0	10.1	-	-	-
Late vegetative	8.5	1.7	34.7	45.1	10.0	65.2	32.2	1.9
Signal grass *(Brachiaria eruci formis, B. erucaeformis)*	6.4	1.0	32.0	47.0	13.6	67.7	38.0	2.1
Ginger grass *(Cymbopogon caesius)*	5.9	5.2	37.1	42.4	9.4	-	-	-
Bermuda grass *(Cynodon dactylon)*								
Fresh	10.5	1.8	28.2	47.7	11.8	71.1	38.1	2.1
Early vegetative	21.9	2.7	18.0	44.8	12.6	-	-	-
Late vegetative	10.0	1.4	31.9	44.1	12.6	-	-	-
Mature	4.9	1.2	39.7	46.1	8.1	-	-	-
Stargrass *(Cynodon plectostachyus)*								
Early vegetative	9.4	0.9	30.4	48.1	11.2	72.0	43.0	2.0
Milk stage	7.2	0.9	32.7	51.0	8.2	-	-	-
Late bloom	5.4	0.9	37.6	45.3	10.8	-	-	-
Nut grass *(Cyperus rotundus)*	8.9	2.4	26.7	49.0	13.0	-	-	-
Crowfoot grass *(Dactyloctenium aegyptium)*								
Early vegetative	8.3	2.5	35.2	40.5	13.5	-	-	-
Milk stage	7.2	1.2	33.7	45.4	12.5	-	-	-
Mature	5.7	1.2	27.7	49.8	15.6	69.3	39.8	2.0

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Kikiuyu grass (*Pennisetum clandestinum),* early vegetative	15.7	1.7	27.6	40.2	14.8	65.3	35.1	2.3
Pennisetum orientale, early vegetative	8.2	3.2	27.9	44.6	16.1	71.6	42.5	2.0
Pennisetum pedicellatum, late vegetative	2.9	1.6	35.8	49.6	10.1	75.8	47.4	1.8
Napier grass *(Pennisetum purpureum)*								
Early vegetative	15.6	1.2	27.4	36.7	19.1	-	-	-
Late vegetative	14.5	2.2	27.9	38.3	17.1	-	-	-
Mature	9.2	1.9	29.2	43.1	16.6	71.7	42.6	1.9
Post ripe	6.2	2.3	28.1	47.4	16.0	71.0	31.8	-
Mission grass *(Pennisetum polystachion)*								
Early vegetative	17.4	1.4	23	42.3	15.9	72.7	43.8	1.9
Late vegetative	12.2	1.7	31.4	44.3	10.4	-	-	-
Early bloom	6.4	1.1	28.6	46.3	17.6	-	-	-
Late bloom	5.4	0.8	33.0	47.3	13.5	-	-	-
Milk stage	4.9	0.9	29.9	49.7	14.6	-	-	-
Mature	2.8	1.1	34.5	49.8	11.8	-	-	-
Canary grass *(Phalaris minor)*								
Early vegetative	13.9	5.2	9.9	51.3	19.7	57.2	25.6	2.2
Mid bloom	10	3.7	21.2	47.6	17.5	-	-	-
Napier grass (*Pennisetum purpureum x Pennisetum glaucum),* mature	2.9	1.8	37.2	51.1	7.0	-	-	-
Cabbage (*Brassica oleracea capitata)* Outside leaves	20	3.5	10.3	39.0	27.2	-	-	-
Cauliflower (*Brassica oleracea botrytis),* Leaves	18.8	3.6	10.8	52.9	13.9	-	-	-
Crabgrass (*Digitaria longiflora),* Longiflora, late vegetative	6.0	0.8	24.6	46.2	22.4	-	-	-
Crabgrass *(Digitaria sanguinalis),* hairy, early vegetative	7.1	1.2	33.6	44.9	13.2	-	-	-
Pili grass *(Heteropogon contortus),* mature	5.2	1.8	33.8	50.1	9.1	72.1	43.1	1.9
Dal grass *(Hymenachne pseudointerrupta),* early bloom	9.4	2.3	22.1	54.0	12.2	63.9	33.5	2.2
Tropical cupgrass (*Eriochloa procera),* mature	5.8	0.6	25.3	50.9	17.4	-	-	-
Lovegrass, boer *(Eragrostis chloromelas),* late vegetative	6.8	1.4	37	48.8	6.0	64.5	34.2	2.3
Stink grass *(Eragrostis cilianensis),* late vegetative	11.6	2.5	31.7	43.7	10.5	68.4	36.5	2.2

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Lovegrass (*Eragrostis superba*), late vegetative	5.3	1.1	39.4	47.3	6.9	65.2	35.2	2.2
Weeping lovegrass *(Eragrostis curvula)*, late vegetative	5.2	1.7	36.4	45.6	11.1	74	41.6	-
Early vegetative	5.1	3.0	30.7	51.0	10.2	-	-	-
Late vegetative	5.1	2.9	32.8	47.0	12.2	-	-	-
Early bloom	4.7	2.8	33.2	44.1	15.2	-	-	-
Mature	3.7	2.5	35.8	45.2	12.8	-	-	-
Aerial, fresh	10.2	2.2	23.6	47.3	16.7	-	-	-
Brachiaria decumbens	6.8	1.1	31.5	48.1	12.5	61.8	28.9	2.1
Calopo *(Calopogonium mucunoides)*	15.0	1.5	35.2	41.2	7.1	54.3	44.7	2.0
Early vegetative	7.5	2.5	31.5	41.4	17.1	-	-	-
Mid bloom	8.2	2.4	33.0	43.0	13.4	-	-	-
Mature	5.5	2.3	35.0	43.5	13.7	-	-	-
Bird-woodgrass (*Cenchrus setigerus)*, full bloom	4.4	1.1	34.1	43.6	16.8	72.0	33.6	1.9
Butterfly pea (*Centrosema pubescens)*	11.8	0.7	33.8	44.7	9.0	56.0	39.2	2.2
Chloris virgata	6.4	1.6	32.1	42.5	17.4	-	-	2.0
Convolvulus arvensis	13.2	2.5	29.7	46.8	7.8	-	-	-
Sunhemp *(Crotalaria juncea)*, midbloom	14.2	2.5	33.3	42.0	8.0	-	-	-
Early vegetative	4.5	2.2	33.3	51.0	9.0	-	-	2.3
Late vegetative	4.2	2.2	30.9	51.0	11.7	-	-	-
Midbloom	3.2	2.0	30.4	53.5	10.9	-	-	-
Jungle-rice *(Echinochloa colonum)*, midbloom	5.2	1.8	34.8	45.8	12.4	69.6	40.2	1.9
Eleusine compressa, full bloom	5.6	1.7	29.2	51.5	12.0	-	-	-
Late vegetative	7.6	1.1	33.6	42.6	15.1	-	-	-
Dough stage	6.4	2.1	28.8	50.3	12.4	-	-	-
Early vegetative	8.0	2.3	35.0	45.5	9.2	-	-	-
Late vegetative	7.5	3.4	32.2	47.7	9.2	-	-	-
Teosinte (*Euchlaena mexicana)*, mature	4.5	1.2	32.2	51.3	10.8	60.9	30.0	2.4
Meadow fescue *(Festuca spp.)*	8.9	4.2	24.0	53.7	9.2	-	-	-
Indigo (*Indigofera spicata)*, early vegetative	12.3	9.8	38.4	27.8	11.7	-	-	1.8
Early vegetative	7.0	3.3	34	47.4	8.3	-	-	-
Midbloom	5.5	3.2	32.4	50.7	8.2	-	-	-
Mature	3.5	1.6	39.4	48.7	6.8	-	-	-
Early vegetative	12.3	3.0	26.2	48.2	10.3	-	-	-
Late vegetative	10.5	3.3	25.6	47.5	13.1	-	-	-
Ischaemum rugosum, early bloom	7.1	2.5	29.8	50.5	10.1	-	-	-

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Iseilema anthephoroides, mature	2.6	2.1	34.1	51.0	10.2	-	-	-
Early vegetative	12.2	1.7	31.4	44.3	10.4	-	-	-
Late vegetative	6.4	1.1	28.6	46.3	17.6	-	-	-
Early bloom	5.4	0.8	33.0	47.3	13.5	-	-	-
Full bloom	5.1	1.4	34.2	47.7	11.6	-	-	-
Milk stage	4.9	0.9	29.9	49.7	14.6	-	-	-
Mature	3.7	1.0	38.8	46.7	9.8	-	-	-
Early vegetative	6.0	1.4	36.6	45.8	10.2	-	-	-
Late vegetative	4.2	1.0	38.9	45.6	10.3	-	-	-
Mid bloom	4.1	1.1	41.1	44.3	9.4	-	-	-
Mature	3.2	1.1	37.4	47.7	10.6	68.0	35.4	-
Lasiurus sindicus, early vegetative	10.2	1.5	32.5	46.6	9.2	75.9	47.5	1.9
Grass pea *(Lathyrus sativus)*, milk stage	20.9	1.3	21.2	39.9	16.7	-	-	2.2
Rice grass *(Leersia hexandra)*, late bloom	5.8	2.1	28.4	47.0	16.7	-	-	-
Perennial rye grass *(Lolium perenne)*, early vegetative	12.2	3.6	13.3	63.1	7.8	-	-	-
Early vegetative	25.8	3.1	35.2	24.1	11.8	-	-	-
Late vegetative	20.3	3.1	25.7	36.1	14.8	-	-	-
Early bloom	18.1	2.6	24.9	43.5	10.9	-	-	-
Late bloom	16.9	3.5	29.0	41.8	8.8	-	-	-
Microstegium ciliatum, early bloom	6.0	1.8	37.3	45.2	9.7	-	-	-
Lyon bean (*Mucuna cochinchinensis)*, early vegetative	15.1	2.1	19.3	48.6	14.9	27.9	32.0	2.3
Broomrape *(Oroban haceae spp.)*, early bloom	8.6	1.7	11.3	68.5	9.9	-	-	-
Panicum blue *(Panicum antidotale)*	13.9	2.7	34.6	36.6	12.2	71.7	42.6	1.9
Witchgrass *(Panicum spp.*), late vegetative	8.0	1.4	34.8	42.7	13.1	68.8	40.5	2.1
Panicum sweet (*Panicum laevifolium)*, late bloom	5.4	1.5	40.2	42.4	10.5	65.7	39.8	2.2
Early vegetative	14.0	2.7	41.8	25.4	16.1	-	-	-
Early bloom	7.7	1.7	37.3	39.4	13.9	-	-	-
Mature	4.7	0.7	31.6	51.6	11.4	-	-	-
Paspalum flavidum Fresh, aerial	9.1	1.2	35.4	43.0	11.3	62.3	38.5	2.0
Perotis indica, aerial	2.5	1.6	35.8	50.0	10.1	-	-	-
Polytoca digitata, late vegetative	8.0	1.0	33.8	44.2	13.0	-	-	-
Kudzu Tropical (*Pueraria phaseoloides)*, late vegetative	9.2	1.1	42.3	40.3	7.1	55.4	32.4	2.1

Feed Name	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	NDF (%)	ADF (%)	ME (Mcal)
Early vegetative	14.5	1.1	32.2	41.4	10.8	-	-	-
Late vegetative	13.0	1.1	32.8	43.0	10.1	-	-	-
Early bloom	11.0	1.5	31.3	43.6	12.6	-	-	-
Jhanii (*Scirpus articulatus)*, early vegetative	15.0	1.6	27.1	36.3	20.0	-	-	-
Saingrass (*Sehima nervosum)*, early bloom	5.6	1.6	35.9	42.1	14.8	73.7	44.9	1.9
Early vegetative	14.5	2.0	28.1	40.1	15.3	-	-	-
Late vegetative	13.6	2.0	24.5	40.9	19.0	-	-	-
Early bloom	12.0	2.2	33.4	37.6	14.8	-	-	-
Late vegetative	5.8	1.4	33.3	46.3	13.2	-	-	-
Vetiver *(Vetiveria zizanioides)*, mid bloom	12.7	1.5	30.5	42.3	13.0	68.4	41.3	2.2
Sissoo leave silage *(Dalbergia sissoo)*	3.2	3.3	27.5	51.6	14.4	-	-	2.7
Finger millet straw silage *(Eleusine coracana)*	3.6	1.5	38.8	46.5	9.6	78.9	46.8	2.1
Teonsinte silage *(Euchlaena mexicana)*	5.6	4.6	31.4	48.2	10.2	-	-	-
Spear grass whole silage *(Heteropogon contortus)*	4.5	1.9	33.8	50.3	9.5	72.0	42.9	1.8
Silage, late vegetative	6.9	1.9	27.8	45.5	17.9	-	-	-
Silage, early bloom	6.6	1.3	36.8	43.1	12.2	-	-	-
Silage, mature	6.6	1.6	32.6	43.7	15.5	-	-	-
Guinea grass silage *(Panicum maximum)*	5.2	1.5	38.7	44.7	9.9	-	-	-
Acacia leucophloea, Arini	15.3	2.8	18.8	55.8	7.3	-	-	-
Aeluropus lagopoides	5.7	2.3	33.2	44.4	14.4	66.9	42.8	2.0
Amaranthus spp., Amaranth	11.8	4.5	22.7	49.5	11.5	-	-	-
Anabasis multiflora	2.3	2.6	35.4	49.4	10.3	-	-	-
Andropogen taniger	6.1	1.8	30.5	49.3	12.3	61.2	36.9	2.0
Alysicarpus rugosus, Chainpea	14.7	1.8	39.1	34.6	9.8	51.4	38.1	1.9
Apluda Aristata	6.0	0.9	36.2	47.2	9.7	-	-	-
Apluda varia	8.1	2.4	32.6	42.2	14.7	-	-	-
Aristida depressa	5.0	1.5	37.1	44.4	12.0	62.5	39.5	2.0
Aristida funiculata (full bloom)	2.4	1.1	33.2	53.8	9.5	61.2	38.4	2.0
Arundo donax, Giant reed (full bloom)	13.2	1.9	28.2	41.6	15.1	65.6	35.5	2.1
Basella alba, Spinach	20.9	0.3	0.6	71.2	7.0	60.4	36.4	2.1
Palisade grass (*Brachiaria brizantha)*, late bloom	36.5	40.7	10.5	11.2	7.1	12.5	64.0	2.0

Annex Table 14. 3: Proximate composition of unconventional feeds (on dry matter basis)

Unconventional feeds	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)	ME (Mcal)
Niger seed cake (*Guizotia abyssinica*)	34.0	1.2	22.3	30.4	12.0	1.8
Rubber seed cake (*Hevea brasiliensis*)	35.0	12.1	7.1	34.8	10.5	2.4
Sun hemp seeds (*Crotalaria juncea*)	40.3	1.4	10.0	42.7	5.6	2.5
Dhaincha seeds (*Sesbania bispinosa*)	32.7	2.9	10.7	48.7	5.0	-
Corn gluten meal (*Zea mays*)	58.0	2.0	4.6	43.1	2.3	2.9
Ambadi cake (*Hibiscus cannabinus*)	23.4	4.2	22.6	38.3	9.9	2.2
Guar meal (*Cyamopsis tetragonoloba*)	50.0	5.2	7.2	35.9	8.8	2.9
Castor bean meal (*Ricinus communis*)	30.0	-	-	-	-	2.0
Pilludi cake (*Salvadora oleoides)*	24.0	-	-	50	-	1.9
Subabul seeds (*Leucaena leucocephala)*	29.0	7.5	11.4	40.9	4.4	2.3
Jowar gluten (*Sorghum vulgare)*	39.0	-	-	-	--	2.3
Jowar cake	10.0	6.6	12.1	69.5	-	2.4
Corn steep liquor	52.0	2.7		26.0	-	2.7
Isabgol lali (*Plantago ovata)*	32.2	21.3	1.0	28.1	-	-
Tamarind seed powder (*Tamarindus indica)*	12.0	7.4	26.4	44.4	3.5	2.3
Mango seed kernels (*Mangifera indica*)	6.0	8.9	2.8	74.4	5.4	2.0
Rain tree pods (*Samanea saman*)	16.7	0.7	14.5	69.6	2.4	2.3
Kusum cake (*Schleichera oleosa*)	20.9	7.4	9.0	56.9	5.8	2.8
Cocoa pods (*Theobroma cacao*)	6.3	0.5	24.0	61.4	7.8	2.2
Vilayati Babul pods (*Prosopis juliflora*)	12.0	3.0	27.7	50.6	4.8	2.3
Damaged apple waste (*Malus domestica*)	12.0	-	-	-	-	2.2
Tapioca starch waste	12.0	0.6	26.9	66.9	3.4	2.2
Tapioca milk residue	3.5	3.5	2.5	-	-	-
Seaweed meal (*Sargassum* spp.)	10.0	0.8	10.3	48.0	-	-
Babul pods (*Acacia nilotica*)	12.0	2.3	12.3	67.0	5.3	2.0
Babul seed chuni	16.0	-	-	39.5	-	2.0
Jack fruit waste (*Artocarpus heterophyllus)*	7.7	-	14.1	65.3	-	0.72

Sugarcane bagasse (*Saccharum officinarum)*	3.5	0.3	50.1	46.1	2.5	1.3
Sugarcane bagasse pith	1.7	1.5	45.1	49.2	2.5	-
Sugarcane tops	3.2	1.7	33.5	50.3	8.5	1.6
Panewar seeds (*Cassia tora*)	16.0	7.4	4.6	60.7	9.1	2.0
Warai bran (*Panicum miliaceum*)	6.2	4.8	18.7	-	-	2.0
Tea waste (*Camellia assamica*)	17.9	-	-	-	-	2.0
Tomato waste (*Lycopersicon esculentum)*	15.0	18.0	-	40.0	-	2.0
Banana root bulbs (*Musa paradisiaca)*	12.0	2.8	47.2	42.2	-	1.8
Potato waste (*Solanum tuberosum*)	7.6	7.0	4.0	-	4.0	-
Citrus by-product (*Citrus Spp.)*	4.2	1.5	7.0	65.0	4.0	-

Annex Table 14.4. Mineral contents of concentrates (on dry matter basis)

Ingredient	Ca (%)	P (%)	Mg (%)	K (%)	Na (%)	Cl (%)	S (%)	Co (ppm)	Cu (ppm)	I (ppm)	Fe (ppm)	Mn (ppm)	Se (ppm)	Zn (ppm)	Mo (ppm)
Grains and seeds															
Maize	0.02	0.35	0.12	0.42	0.02	0.08	0.10	-	1.00	-	59	7	0.07	21	0.7
Sorghum	0.03	0.25	0.17	0.47	0.01	0.06	0.11	-	10.00	-	284	44	-	34	2.3
Wheat	0.03	0.28	0.15	0.50	0.01	0.01	0.15	-	5.00	-	72	42	0.28	40	1.3
Barley	0.05	0.38	0.14	0.56	0.02	0.13	0.12	0.35	6.00	-	70	22	0.11	38	1.1
Oats	0.07	0.30	0.16	0.52	0.03	-	0.19	0.06	8.00	-	106	43	0.48	41	1.7
Rice	0.02	0.28	0.1	0.25	0.01	-	0.1	0.13	13.79	-	655.8	39.45	0.07	24.46	0.41
Rye	0.07	0.37	0.14	0.52	0.03	0.03	0.17		8.00	-	69.0	66.0	0.44	36.0	-
Bajra	0.08	0.38	0.59	0.97	0.10	-	0.19	0.31	6.07	-	234.7	33.35	0.19	28.78	0.54
Milling by-products															
Wheat bran	0.17	0.93	0.53	1.32	0.04	0.16	0.21	-	11	-	157	122	0.50	85	2.5
Wheat middlings	0.16	1.02	0.42	1.38	0.03	0.10	0.18	-	10	-	158	125	0.46	91	2.5
Rice bran	0.07	1.33	0.81	1.57	0.03	0.09	0.19	-	10	-	239	186	0.17	71	2.8
Rice polish	0.07	1.58	0.42	0.81	0.01	-	0.13	0.52	10.68	-	543.7	118.46	0.28	38.26	0.47
Brewer's grain	0.30	0.67	0.26	0.50	0.04	0.07	0.38	-	11	-	224	45	1.06	85	3.2
Distiller's grain	0.11	0.43	0.07	0.18	0.10	0.08	0.10	0.46	0.09	48.0	0.05	223.0	23.0	0.48	35.0
Distiller's soluble	0.22	0.83	0.33	1.10	0.30	0.26	0.44	-	8	-	178	27	0.39	65	1.9
Molasses															
Cane molasses	0.40	0.23	0.42	4.01	0.22	-	0.47	-	66	-	263	59	-	21	1.6
Beet molasses	0.15	0.03	0.29	6.06	1.48	-	0.60	-	22	-	87	66	-	18	0.5
Citrus molasses	1.92	0.12	0.12	1.10	0.06	0.08	0.10	-	8	-	151	9	-	11	0.9
Roots															
Turnip	0.59	0.26	0.22	2.99	1.05	0.65	0.43	-	21.0	-	118.0	43.0	-	-	-
Sugar beet	0.91	0.09	0.23	0.96	0.31	0.18	0.30	-	11	-	642	62	0.14	22	1.5
Tubers															
Cassava	0.28	0.19	-	0.26	-	-	-	-	-	-	9.0	20.0	-	-	-

Potato	0.49	0.29	0.11	1.04	0.26	0.19	0.11	-	11	-	1006	26	-	25	1.6
Carrot	0.27	0.27	0.20	2.80	1.04	0.50	0.17	-	10.0	-	120.0	31.0	-	-	-
Plant protein concentrates															
Soybean meal	0.22	0.63	0.30	2.12	0.04	0.10	0.34	-	17	0.12	169	39	-	72	3.8
Groundnut meal	0.18	0.60	0.32	1.32	0.03	0.10	0.32	-	13	0.07	302	33	0.21	54	3.8
Cottonseed cake (Decorticated)	0.17	0.60	0.37	1.13	0.02	0.06	0.23	-	7	-	94	18	0.14	37	1.3
Cottonseed cake (undecorticated)	0.12	0.30	0.29	1.1	0.03	-	0.22	0.42	9.97	-	450.6	0.29	0.11	31.22	0.35
Rapeseed meal	0.73	0.85	0.54	0.90	0.50	-	-	-	7.0	-	190.0	60.0	1.04	47.0	-
Sunflower meal	0.33	0.93	0.63	1.50	0.04	0.12	0.39	-	32	-	298	45	0.50	88	2.7
Safflower meal	0.20	0.60	0.39	1.21	0.04	-	0.32	-	22	-	319	30	-	77	2.3
Sesame meal	1.33	0.90	0.50	1.35	0.04	0.07	0.35	-	-	-	100.0	52.0	-	32.0	-
Coconut meal	0.15	0.50	0.33	1.62	0.04	-	0.36	0.14	15.0	-	1651.	71.0	-	-	-
Linseed meal	0.40	1.20	0.55	1.22	0.09	-	0.37	-	19	-	369	39	1.05	69	2.0

Annex Table 14.5 **Mineral contents of roughages (on dry matter basis)**

Ingredient	Ca (%)	P (%)	Mg (%)	K (%)	Na (%)	Cl (%)	S (%)	Co (ppm)	Cu (ppm)	I (ppm)	Fe (ppm)	Mn (ppm)	Se (ppm)	Zn (ppm)	Mo (ppm)
Hay (sun-cured)															
Jowar hay	0.83	0.75	0.28	0.97	0.01	-	0.09	0.19	5.96	-	472.19	30.54	0.08	33.77	0.39
Grass hay	0.42	0.25	0.18	0.16	0.01	-	0.12	0.36	4.23	-	571.37	62.23	0.14	23.31	0.17
Apluda mutica	0.20	0.034	0.003	0.72		-	-	0.042	10.0	-		7.5	--	14.0	-
Peanut *(Arachis hypogaea)*	1.24	0.65	0.21	0.51	0.69	-	-	-	-	-	-	-	-	-	-
Oats *(Avena sativa)*	0.30	0.35	0.26	1.51	0.18	0.52	0.25	0.07	15.0	-	155.0	64.0	0.17	39.0	-
Bermuda grass *(Cynodon dactylon)*	0.47	0.17	017	1.53	0.08	-	0.21	0.12	-	0.12	290.0	-	-	-	-
Soybean *(Glycine max)*	1.29	0.28	0.79	1.07	0.09	0.15	0.24	0.09	9.0	0.24	292.0	106.0	-	24.0	-
Lucerne *(Medicago sativa)*	2.00	0.40	0.30	2.26	0.17	0.37	0.30	0.23	11.0	-	195.0	31.0	0.54	24.0	-
Berseem *(Trifolium alexandrinum)*	2.00	0.38	0.43	1.62	0.19	0.32	0.17	0.16	11.0	0.25	184.0	73.0	-	17.0	-
Wheat *(Triticum aestivum)*	0.15	0.20	0.12	1.00	0.21	0.22	-	-	-	200.0	-	-	-	-	-
Cowpea *(Vigna sinensis)*	2.33	0.88	0.45	2.26	0.27	0.17	0.35	0.07	-	-	300.0	-	-	-	-
Maize *(Zea mays)*	0.42	0.14	0.37	1.13	0.01	-	0.13	0.38	9.35	-	616.56	53.41	0.08	39.55	0.35
Straws															
Peanut *(Arachis hypogaea)*	1.29	0.12	0.58	1.12	0.03	-	0.13	0.75	10.93	-	1345.22	71.0	0.09	18.72	0.19
Oats *(Avena sativa)*	0.24	0.06	0.18	2.57	0.42	0.78	0.23	-	10.0	-	175.0	37.0	-	6.0	-
Barley *(Hordeum vulgare)*	0.30	0.30	0.23	2.37	0.14	0.67	0.17	0.07	5.0	-	201.0	17.0	-	7.0	-
Bean, mung *(Phaseolus aureus)*	0.81	0.13	0.09	0.3	-	0.07	0.7	3.01	-	117.9	10.42	0.38	20.4	0.39	-
Wheat *(Triticum aestivum)*	0.30	0.10	0.15	1.23	0.04	-	0.14	0.45	3.96	-	812.03	63.24	0.15	11.89	-

Annex Table 14.6. **Commonly used mineral salts along with % active element**

Mineral Element	**Name of the compound**	**Chemical formula**	**Mol. Wt. (g/mol)**	**Active element (%)**	
Calcium (40.08)	Di-calcium phosphate, di-hydrate	$CaHPO_4$. $2H_2O$	172	Ca: 23	P: 18
	Mono-calcium phosphate, monohydrate	$Ca(H_2PO_4)_2$. H_2O	252	Ca: 16	P: 24
	Calcium carbonate/ Lime stone powder	$CaCO_3$	100.08	Ca: 40	
	Calcium chloride	$CaCl_2$	110.9	Ca: 36	
	Dolomitic limestone	$CaCO_3.MgCO_3$	184	Ca: 22	Mg: 13
	Calcium oxide	CaO	56.08	Ca: 71.4	
	Calcium hydroxide	$Ca\ (OH)_2$	74.08	Ca: 54	
Phosphorus (30.97)	Sodium di-hydrogen phosphate (Mono-basic)	NaH_2PO_4	120	Na: 19	P: 26
	Di-sodium hydrogen phosphate (Di-basic)	Na_2HPO_4	142	Na: 32	P: 22
	Tri-sodium phosphate (Tri-basic)	Na_3PO_4	164	Na: 42	P: 19
	Mono-potassium phosphate	KH_2PO_4	136	K: 29	P: 23
	Di-potassium phosphate	K_2HPO_4	174	K: 44	P: 18
	Tri-potassium phosphate	K_3PO_4	212	K: 54	P: 15
	Phosphoric acid	H_3PO_4	98	P: 32	
Sodium (22.99)	Sodium chloride	NaCl	58.45	Na: 39	Cl: 61
	Sodium bi-carbonate	$NaHCO_3$	84	Na: 27	
Potassium (39.09)	Potassium chloride	KCl	74.55	K: 52	Cl: 48
	Potassium sulphate	K_2SO_4	174.26	K: 44	S: 18
Iodine (126.9)	Potassium iodide	KI	165.9	K: 24	I: 76
	Potassium iodate	KIO_3	213.9	K: 18	I: 59
	Calcium iodate	$Ca(IO_3)_2$	389.88	Ca:10	I: 66
	Copper iodide	CuI	190.45	Cu:33	I: 67
Copper (63.55)	Copper sulphate, anhydrous	$CuSO_4$	159.5	Cu:40	S: 20
	Copper sulphate, pentahydrate	$CuSO_4.5H_2O$	249.5	Cu:25	S: 13
	Copper Chloride	$CuCl_2$	134.4	Cu: 47	Cl:53
	Copper carbonate	$CuCO_3$	123.5	Cu: 51	

Mineral Element	**Name of the compound**	**Chemical formula**	**Mol. Wt. (g/mol)**	**Active element (%)**	
Zinc (65.39)	Zinc sulphate, anhydrous	$ZnSO_4$	161.4	Zn: 41	S: 20
	Zinc sulphate, monohydrate	$ZnSO_4.H_2O$	179.4	Zn: 36	S: 18
	Zinc sulphate, heptahydrate	$ZnSO_4.7H_2O$	287.4	Zn: 23	S: 11
	Zinc oxide	ZnO	81.4	Zn: 80	
	Zinc carbonate	$ZnCO_3$	125.4	Zn: 52	
	Zinc chloride	$ZnCl_2$	136.3	Zn: 48	Cl: 52
Manganese (54.94)	Manganese sulphate, anhydrous	$MnSO_4$	150.94	Mn: 36	S: 21
	Manganese sulphate, monohydrate	$MnSO_4.H_2O$	168.94	Mn: 33	S: 19
	Manganese carbonate	$MnCO_3$	114.94	Mn: 48	
Cobalt (58.93)	Cobalt sulphate, anhydrous	$CoSO_4$	154.93	Co: 38	S: 21
	Cobalt sulphate, monohydrate	$CoSO_4.H_2O$	172.93	Co: 34	S: 19
	Cobalt sulphate, heptahydrate	$CoSO_4.7H_2O$	280.93	Co: 21	S: 11
	Cobalt chloride	$CoCl_2$	129.83	Co: 45	Cl: 55
	Cobalt carbonate	$CoCO_3$	118.93	Co: 50	
Iron (55.84)	Ferrous sulphate, anhydrous	$FeSO_4$	151.84	Fe: 37	S: 21
	Ferrous sulphate, monohydrate	$FeSO_4.H_2O$	169.84	Fe: 33	S: 19
	Ferrous sulphate, hepta-hydrate	$FeSO_4.7H_2O$	277.84	Fe: 20	S: 12
	Ferrous carbonate	$FeCO_3$	115.84	Fe: 48	
Magnesium (24.3)	Magnesium sulphate, anhydrous	$MgSO_4$	120	Mg: 20	S: 27
	Magnesium sulphate, hepta-hydrate	$MgSO_4.7H_2O$	246	Mg: 9.8	S: 13
	Magnesium oxide	MgO	40	Mg: 60	
	Magnesium chloride	$MgCl_2$	94.9	Mg: 25	Cl: 75
	Magnesium carbonate	$MgCO_3$	84	Mg: 28.5	
	Magnesium hydroxide	$Mg\ (OH)_2$	58	Mg: 41	
Sulphur (32.06)	Sodium thiosulphate, anhydrous	$Na_2S_2O_3$	158	Na: 29	S: 40.5
	Sodium thiosulphate, pentahydrate	$Na_2S_2O_3.5H_2O$	248	Na: 18.5	S: 25.8
	Sodium sulphate	Na_2SO_4	142	Na: 32.4	S: 22.5

Mineral Element	Name of the compound	Chemical formula	Mol. Wt. (g/mol)	Active element (%)	
	Calcium sulphate	$CaSO_4$	136	Ca: 29.4	S: 23.5
	Ammonium sulphate	$(NH_4)_2SO_4$	132	N: 21	S: 24.2
Selenium (78.96)	Sodium selenite	Na_2SeO_3	172.96	Na: 26.6	Se:45.65
	Sodium selenite	Na_2SeO_4	188.96	Na: 24.30	Se:41.8
Chromium (51.99)	Chromium sulphate	$Cr_2(SO_4)_3.12\ H_2O$	392.16	Cr:26	S: 24
	Cromium (III) picolinate	$Cr\ (C_6H_4NO_2)_3$	418.33	Cr: 12	

References fot this Annexes

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Annex 15

Problem identified in State Level Workshop (May 2019)

Compilation of views, suggestion and recommendation from the State level Interaction Workshop on Feeds and Feeding Policy at the 4 DLSU (i.e. State Level)

DLSU Biratnagar (State 1)

Table 15. 1. Compilation of views, suggestion and recommendation from the State level Interaction Workshop at DLSU Biratnagar

	Problems	Suggestion to solve the problems
1.Fodder production	1. Shortage of land for fodder production.	1. Government land should be made available to the farmerson lease.
	2.Feed shortage during winter	1. Round the year fodder production should be promoted to make available feed throughout the year, to reduce the cost of production and to improve health status.
	3.Lack of fodder seeds and saplings	1. Available seed production farms (government and private) are not adequate to supply the fodder seeds and saplings in the states. The capacity of government farms should be improved and farmers need to be included in seed and sapling production.
	4. Lack of facilities for fodder conservation	1. Program for fodder conservation such as silage and hay making should be promoted. 2.Silage production cooperatives should be promoted 3.Training to the silage producing farmers 4. Provision to transport silage from Terai (State 1) to hills like Ilam, Panchthra, Taplejung, Dhankuta and other nearby places.
	5 Lack of knowledge on the use of fodder	1. Training to the farmers involved in fodder production, andfodder conservation for winter feeding. 2. Need of “Ration Balancing” training to the farmers and technicians from Livestock Services Section (Municipalities and Rural

		Municipality). Existing VHLSEC should also be involved.
	6.Lack of feed and odder policy	1. Feed and fodder policy needs to be prepared and put in use. 2. Feed Feeding Reference Standard (FFRS) needs to be prepared and executed. 3. Consider the programs for fodder production like Prime Minister Rice zone.
	7.Shortage of work force	1. Youth should be encouraged in livestock farming considering the fodder farming 2. Local Livestock Service Section (LSS) should be equipped with trained technician on fodder production and conservation to provide the services to the livestock keepers.
	8. .Lack of mechanization	1. Should be a provision for mechanization, both for fodder production and conservation.
2.Seed production and marketing	1. Shortage of quality fodder seeds within the state. 2.Non-use of Truthful Labelled fodder seeds for fodder production. 3. Shortage of seed processing equipment and plants. 4. Lack of labs for fodder seed testing. 5. Lack of fodder seed production farms .	1. Need to promote fodder seed marketing network, considering milk cooperatives. 2. Preparation and updating the production of Truthfully Labelled Seeds. 3. Provision of soft lone to procure the equipment for seed processing. 4. Fodder seed tasting labs need to be established 5.Cost of seed production is currently high,it is not able to match the selling price.
3.Feed Manufacturing	1. Lack of feed manufacturing plants in the Eastern sector. Not more than 10 feed plants are in operation in state 1 and, therefore,feeds are transported from Western Nepal that costs more. 2. Lack of feed experts in the state. 3.. Feed ingredients are imported 4. Irregularitiesin the import of feed ingredients.	1. Cooperatives should be encouraged in feed manufacturing. 2. Government should arrange the availability of feed experts for quality feed production. 3. Need to use local feed ingredients to reduce the production cost. 4. Guidelines need to prepared and strictly followed for the import of feed ingredients.

3. 3.2. DLSU Hetaunda(State 2 and 3)

Table 15.2. Compilation of views, suggestion and recommendations from the State level Interaction Workshop at DLSU Hetaunda

	Problems	**Suggestion to solve the problems**
1.Fodder production	1. Land shortage for fodder production.	1. Government land (Community land) should be made available on lease to the farmers
	2.Feed transportation	1. Feed transportation is a problem as most of the districts in state 3 are in the hills that support the need of TMR plants establishment.
	3.Feed shortage during winter	1. Round the year feed production should be promoted to reduce the cost of feed production, and health improvement 2.Feed quality of crop residues needs to be improved for winter feeding, through TMR 3.Preparation of silage needs to be promoted for winter feeding to support the improved cattle and buffalo in states two and three.
	4. Lack of fodder seed and sapling with prioritized fodder species.	1. Available seed production farms (government and private) are not adequate to supply the fodder seeds and saplings. The farms areunderutilized, considering their production potential. Farms/research stations are not efficient/sufficient to supply the demand of seeds. These farms/stations are (1) Fodder crop Genetic Resource Center Ranjitpur (2) Rhizobium and Fodder Seed Laboratory, Janakpur. (3) Pasture and Fodder Division, Khumaltar under NARC management, (4) National Cattle Research Program, Rampur Chitwan under NARC.(5) Pasture and Fodder Research Center, Dhunche, Rasuwa (For pasture seed for high mountain districts) under NARC. 2. Very few fodder nurseries are available withinstate and nearby states for fodder sapling production. The potential farms for sapling production are (1) Government farms: as of above

	Problems	Suggestion to solve the problems
		and (2) Private nurseries: few are there but more need to be established. 3. Fodder species suitable for the state, have not been prioritized, that needs to prioritization.
	5. Lack of facilities for fodder conservation	1. Program for fodder conservation such as silage and hay making should be promoted. 2.Silage production agencies should be promoted through the milk cooperatives. 3.Training to the silage producing farmers 4. Provision to transport the silage from Terai (State 2,3) to hills like Kavre, Kathmandu, Makwanpur and other nearby districts.
	6. Lack of knowledge on the use of fodder	1. Training to the farmers involved in fodder production, and fodder conservation for winter feeding. 2. Need of “Ration Balancing for Livestock: training to the farmers and technicians from Livestock Services Section (Municipalities and Rural Municipality in states 2 and 3 with the help of experts.
	6.Lack of feed and fodder policy	1. Feed and fodder policy needs to be prepared and used in field. 2. Feeds and Fodder Referenced Standard (FFRS) needs to be prepared and implemented. 3. Consider the Pocket Zone for fodder production like Prime Minister Rice Zone needs to be promoted.
	7.Shortage of work force	1. Youth should be encouraged in fodder farming to support the dairy farming in the State level. . 2.Local Livestock Service Section (LSS) should be equipped with trained technician on fodder production and conservation to provide the service to the livestock keeper in the state.
	8.Lack of mechanization	1. There should be provision of mechanization for both fodder production and conservation. 2.Small power tiller tractor (for the

	Problems	Suggestion to solve the problems
		hills) needs to be promoted to make farm business easy.
2.Seed production and marketing	1.Shortage of quality fodder seeds has been observed within the state. 2.Non-use of Truthfully Labelled fodder seeds. 3. Shortage of seed processing plants. 4. Lack of labs for fodder seed testing. 5. Lack of fodder seeds production farms within the state and even in nearby states.	1. Need to promote the fodder seed marketing network considering the cooperatives and agro vets. 2.Preparation and updating the Truthful Labelled seed producer and seed purchaser. 3. Provision of soft lone to procure (a) seed (b) the equipment for seed processing. 4. Fodder seed tasting labs need to be establishedat State level. 5. Use of technology to reduce the cost of seed production, currently it is high and not able to match the selling price. 6.Use of existingPasture and Fodder Development/Research farms for seed production 7. Establishment of fodder seed resource center within the state for regular seed supply,at private level. .
3.Feed Manufacturing	1. Lack of feed manufacturing plants to fulfill the demand. The feed produced within the state has been transported to other states. More than 75 feed plants are located in State 2 and 3 but not enough to supply the required concentrate feeds. (2) Feed ingredients are mostly imported andthe supply is irregular.	1. Milk cooperativesshould be encouraged for feed manufacturing. 2. Hetaunda Cattle Feed managed by DDC at Hetaunda needs to be upgraded for manufacturing mineral mixture and UMMB. 3. Government should arrange the availability of feed experts for quality feed production. 4. Need to use local feed ingredients to reduce the production cost. 5.Guidelines for the import of feed ingredients need to be laid and strictly adhered to.

3. 3.3. DLSU Butwal (State 5)

Table 15. 3. Compilation of views, suggestions and recommendations from the State level Interaction Workshop at DLSU Butwal

	Problems	Suggestion to solve the problems
1.Fodder production	1.Lack of land, mainly used for food grain, and ploting. 2. Lack of irrigation 3. Shortage of chemical fertilizers 4. Lack of mechanization 5. Banks do not provide loans for fodder cultivation	1. Provision of land on lease. 2. Provision of irrigation 3. Availability of chemical fertilizer on time 4. Support to buy machines for seed production and processing 5. Provision of soft loans for fodder and fodder seed production. 6.Provision of training to the farmers.
2.Seed production and marketing	1.Lack of quality fodder seeds 2. Lack of loan to invest in fodder seed production 3.Lack of fodder seed quality testing laboratories 4. Un controlled seed prices 5.Lack of location specific fodder seedsof good quality.	1. Government should give priority to produce and distributefodder seeds (perennial fodder) through seedproducing groups, commercial farmers and cooperatives 2.Establishement of seed resource center (seed bank) in both government and private sectors 3.Establishment of seed quality tasting laboratories. 4. Development of mechanism to control the price of fodder seeds to make uniform rate through the country. 5. Promotion offodder seed value chain. 6.Establishment of fodder nursery to produce the location specific suitable fodder saplings.
3.Feed Manufacturing	1. Shortage of quality feed producing units (only less than 10 commercial feed industries available in state five) 2. Lack of labeling on the feed bags 3. Incoming low quality compounded feed from neighboring countries. 4.Lack of technical knowledge of	1.Feed producing factories are not in adequate number.Only 10 feed factories are running in the state. Therefore, feed manufacturing factories need to be added for more feed production.

	farmers about the quality of feed (cannot distinguish between wheat and rice bran) 5. Less availability of quality compounded feedsfor the livestock keepers.	2.Feed factories need to be established and operated through themilk cooperatives andthe user groups. Government should support in this regard. 3. Provide training on the feed act and regulation to the farmers,feed manufacturers and feed traders. 4. Needs monitoring to control the feed quality throughenforcement of the Feed Act.

3. 3.4. **DLSU** Pokhara (State 4)

Table 15. 4. Compilation of views, suggestions and recommendations from the State level Interaction Workshop at DLSU Pokhara

	Problems	Suggestions to solve the problems
1.Fodder production	1. Lack of fodder policies to address the feed production and conservation 2.Lack of promising fodder species suitable for different agro ecological zones of the country. 3. Shortage of laborfor fodder production 4.Lack of year round fodder production plan of action with inputs. 5. Lack of knowledge on fodder production, conservation and utilization in the animal farming communities. 6.Less priority on fodder seed quality control by Seed Quality Control Center (SQCC)	1. Need to work out the long term feed fodder policy to address the problems faced by the farmers 2. Explore the suitable fodder species, including local species, with their verities by research. 3. Need to introduce the mechanization (farm machines; small, medium and large) 4. Only winter fodder promotion has been adopted but even summer fodder needs to be promoted. 5. Fodder conservation as Promoting of silage and hay making is needed. 6.Need to include the capacity development program suitable to farmers and technicines. 7.SQCC should plan to control the seef quality of the fodder and tree fodder in the state.
2.Seed production and marketing	1. Insufficient quality fodder seeds 2. Insufficient fodder saplings	1. Promotion of seed growers to produce the quality fodder

	3.Truthful labelled fodder seeds not adapted by the fodder seed growers. 4.Lack of knowledge on the fodder seeds production 5. Seed market has not been well established.	seeds. 2.Establishment of fodder saplings 3. Promotion of Agro vets for fodder seed marketing. 4.Capacity building training to the fodder seed producers and traders. 5. Use of milk Cooperatives for seed distribution to the famers.
3.Feed Manufacturing	1. Concentrate feedsare not adequatelyproduced tofulfill the local demand. 2. Distributed feeds are of substandard, and no quality label as specified by the Feed Act has been adopted. 3.Expensive mineral mixture with sub slanderedquality is being used.	1.Establishment of feed factories with the participation of cooperatives 2. Establishment of feed quality control labs in the state. 3. Promote feed ingredients production to support the production of compounded feed like maize and soybean 4. Production of mineral mixture in the country to supplement the dairy animalsdiets. 5. Level of aflatoxin of 50 ppb needs to be reduced to 35 to improve the feed quality. 6. Feed and feeding Reference (FFRS) needs to be formulated to control the antibiotic residues and use of probiotics in the feed. The feed Act is not enough for quality feed and feeding. 7.Rennovation of DFTQC labs. 8. Establishment of Feed Quality Control Lab (FQCL) under the State level managed by “Department of Livestock Services”. It will help to maintain the feed quality. (9) A regular monitoring (at least once in a month) is required by State Level DLS (A feed quality inspection Committee is required).

Table 15. 5 Field survey under the project districts (selected considering the agro ecological zone

Districts	Fodders		Crop Residues	Crop by-products	Use of Concentrate feeds
	1.Cultivated fodders	2.Tree fodder			
1.Jhapa	(1) Oat, Berseem Napier, and local forage: Banso	Badahar, Ipil ipil,	Rice straw, corn stover, millet straw,	Crop grain byproducts: Oil cake, rice bram (Cooked and fed to the animal)	Semi and commercial dairy farms are using the commercial compounded concentrate feed without considering the daily milk production. • Compounded feed have been cooked.
2.Ilam	Oat, Napier, Amriso, and local forage: Banso	Dudhilo, Painyu, Ipil ipil, Bakaino, Raykhnyu, Kutmiro,Chuletro.	Rice straw, corn stover, Millet straw	Crop grain byproducts: Oil cake, rice bram	1.Semi and commercial dairy farms are using the commercial compounded (from Jhapa) concentrate feed without considering the daily milk production. 2.Silage is transported from Sarlahi
3.Siraha	Oat, Berseem, Napier, Amriso, and local forage.	Badahar, Ipil-ipil, Bakaino,	Rice straw, wheat straw, oil crop residue beg assess,	Rice bran, wheat bran, Molasses	Semi and commercial dairy farm are using the commercial compounded concentrate feed without considering the daily milk production. 2.Silage has not been used to feed to the livestock in the district.
4.Hetaunda	Oat, Berseem, Napier, Amriso, and local forage.	Dudhilo, Ipil ipil, Bakaino, Raykhnyu, Kutmiro, Chuletro.	Rice straw, wheat straw, oil crop residue beg assess,	Rice bran, wheat bran, Molasses	Semi and commercial dairy farm are using the commercial compounded (from Chitwan) concentrate feed without considering the daily milk

					production. 2. Some farmers are using silage to feed to the livestock in the district.
5.Butwal	Oat, Berseem, Napier, sorghum Amriso, and local forage.	Ipil ipil, Bakaino, Raykhnyu, Kutmiro, Chuletro.	Rice straw, wheat straw, oil crop residue beg assess,	Rice bran, wheat bran, Molasses	Semi and commercial dairy farm are using the commercial compoundedconcentrate feed without considering the daily milk production. 2. Some farmers are using silage to feed to the livestock in the district.
6.Shyangjha	Oat, Berseem, Napier, sorghum Amriso, and local forage.	Ipil ipil, Bakaino, Raykhnyu, Kutmiro, Chuletro.	Rice straw, wheat straw, oil crop residue beg assess,	Rice bran, wheat bran, Molasses	Semi and commercial dairy farm are using the commercial compounded concentrate feed without considering the daily milk production. 2. Very few farmers are using silage to feed to the livestock in the district.
7.Kashki	Oat, Berseem, Napier, sorghum Amriso, and local forage.	Ipil ipil, Bakaino, Raykhnyu, Kutmiro, Chuletro.	Rice straw, wheat straw, oil crop residue beg assess,	Rice bran, wheat bran, Molasses	Semi and commercial dairy farm are using the commercial compounded concentrate feed without considering the daily milk production. 2. Some farmers are using silage to feed to the livestock in the district.

The end of Part I

Section Two
Standard Operating Procedures (SOPs) for Animal Feed and Nutrition

Standard Operating Procedures (SOPs) for Animal Feed and Nutrition

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Nepal Livestock Sector Innovation Project (NLSIP) P156797
(Contract ID:NP-MOLD-96297-CS-INDV)

26th July, 2019

Introduction

Under the present report of phase II, Standard Operating Procedures (SOPs) of various technological interventions suggested under phase I, are given. These are listed below:

- **Ration balancing program:**Under the ration balancing program (RBP), various requirements to develop RBP software are given. Information on chemical composition and nutrient requirement of animals for various physiological is given. Implementation arrangement, data monitoring and outcome of RBP are also described, including the environmental sustainability.
- **Mineral mixture production:** Functions of macro and micro minerals in animals are described briefly. Mineral mixture manufacturing procedure is described. List of macro and micro minerals required to be used in mineral mixture formulation is given. Details of the equipment required for mineral mixture production and the space requirement are also given. Safety aspects while manufacturing mineral mixture are described. In the last mineral mixture specification and ingredient composition is given for the convenience of mineral mixture manufacturers.
- **Production of Urea Molasses Mineral Block (UMMB) Lick:** Why UMMB use is recommended on crop residues based diets, is described briefly. UMMB formulation and the manufacturing process is given. Details of the UMMB plant and the space requirement are given under this chapter, including the safety aspects. Benefits of UMMB feeding are described and how it's feeding helps in reducing methane, the most impotent greenhouse gas.
- **Enrichment and densification of crop residues:** Crop residues can be transported and stored from the surplus to deficit areas with enrichment and densification. Formulation that can sustain 5-8 liters milk per day is given. Details of the plant and space required, along with the safety aspects, are described.
- **Compound cattle feed and mineral mixture Order:** Terminology used in the manufacturing and quality monitoring of compound cattle feed and mineral mixture is defined. Details related to requirements for obtaining the license, sampling procedure, formulations, reference of test methods and all other relevant details with regard to manufacturing and quality monitoring of various variants of compound cattle feed and mineral mixture are also given under this chapter.
- **Establishment of Quality Control (QC) labs:** For quality monitoring of feeds and fodders, existing QC labs need to be strengthened and new labs could be established, if required. Under this chapter, all requirements with regard to QC lab are given, including the space requirement, equipment details, glassware and chemicals. Safety aspects required to be followed in a QC lab are also described.
- **Plant for production of bypass protein supplement:** Bypass protein technology and its relevance for milk production enhancement is described under this chapter. Detailed specifications of the plant, space requirement, safety aspects and levels of formaldehyde required to treat locally available protein meals are given.
- **Calf rearing program:** A few pilot projects under the calf rearing project have been suggested. Feed formulations of feeds required to be fed to animals in the advanced stage of pregnancy, young and growing calves are given. Monitoring mechanism and likely outcome is also described. In addition, cost details are given for implementing one module of calf rearing.
- **Details of the green fodder production enhancement:** Details of the protocol required for green fodder production enhancement from cultivated land, pasture and range land, fodder trees, agro-forestry, silvi-pasture etc. are given. Agencies suggested to be used for implementing this program are described and all other relevant details are given.

Chapter 1

Implementation of Ration Balancing Program

1.1 Introduction

Optimal feeding of dairy animals within the available feed resources is important to gain economic benefits of milk production. It is also important to meet the nutritional needs of growing lactating animals in terms of energy, protein, minerals, vitamins etc and to minimize overall cost of feeding. Farmers feed available resources to their animals with deficiency and/or excess of one or other nutrients in the animal ration resulting into inadequate feeding. Educating the farmers on proper use of available feed resources to meet the animal's nutrient requirement at low cost plays a key role to enhance milk production efficiency with better economic returns.

Estimation of nutrient requirement of an animal depends on factors like animal type, class, age, pregnancy status, body weight milk yield, milk fat, months of calving etc. Information on nutrients availability from the feeds and fodder being fed is required to assess the nutrients supply. Based on nutrient requirement and availability of feed resources, a least cost animal ration can be formulated. This formulation is a complex exercise and is very difficult to work out manually. Therefore, Ministry of Agriculture and Livestock, Nepal, the Lead Implementing Agency (LIA) would need to develop a software, under the overall Information Network for Animal Productivity and Health, which can formulate the balanced ration.

1.1.2 What is ration?

Ration of an animal is the fixed amount of feed for one animal fed for a definite period, usually 24 hours.

1.1.3 Balanced Ration

Balanced ration is the ration that provides all the essential nutrients to an animal in such a proportion and amounts that is required for the proper nourishment of animal in 24 hours. A balanced ration would provide protein, energy, minerals and vitamins from dry fodders, green fodders, concentrates, mineral supplements etc., in appropriate quantities to keep the animal in its form to perform best in respect of production, reproduction and health.

1.1.4 Ration Balancing

Ration balancing is the process to balance the level of various nutrients of an animal, from the available feed resources, to meet its nutrient requirements for growth, body maintenance and production.

1.1.5 Disadvantages of imbalanced ration

Imbalanced ration leads to

- Low milk production, poor growth and reproduction.
- Shorter lactation length and increased inter calving period.
- More metabolic diseases such as milk fever and ketosis.
- Slow growth of young animals delaying the age of first calving.
- Low productivity and shorter duration of productive life.

1.1.6 Ration Balancing Program

Ration Balancing Program (RBP) is an advisory program, to educate the farmers on optimum feeding of animals to optimize milk production, meat and wool production by efficient utilization of locally available feed resources at the possible least cost.

1.1.7 Advantages of ration balancing program

- Efficient utilisation of available feed resources.
- Improves milk production efficiency.
- Improvement in fat and SNF per cent.
- Improvement in meat and wool production.
- Possible reduction in daily feeding cost.
- Helps in increasing net daily income to beneficiaries.
- Improves general health of animals.
- Improves reproduction efficiency of animals.
- Better immune response, hence better resistance against diseases.
- Improves growth in calves leading to early maturity.
- Provides employment opportunity to rural women.
- Helps in reducing emission of greenhouse gases per unit of produce.

1.2 Prerequisites of ration balancing program

- Selection and training of supervisory officers and village based local resource persons (LRPs).
- Arrangement of laptop/ desktops/netbooks and other RBP accessories like ear tags, ear tag applicators, applicator pins, measuring tapes and weighing balances.
- Arrangement of internet connectivity, insurance, repair & maintenance of laptops/ desktops/netbooks.
- Identification of villages and regular supply of mineral mixture.

1.3 Ration balancing program component

- Manpower selection and training.
- Procurement management.
- RBP software.
- Ration balancing.

1.4 RBP Manpower selection and training

Manpower selection includes technical specifications for RBP manpower recruitment.

1.5 Technical specifications(TS) of RBP manpower

Manpower required to implement RBP are supervising officers and local resource persons (LRPs). Supervising officers includes Animal Nutritionists, Technical Officers and Trainers. Job specification of each of manpower is given below.

1.5.4 Animal Nutritionist

Animal Nutritionist should preferably be a post graduate in Animal Nutrition with relevant field experience.

1.5.5 Technical officer

Technical officer should be a graduate in veterinary/ animal or agriculture sciences with relevant field experience or preferably post graduate in animal nutrition/livestock production & management with computer literacy.

1.5.6 Trainer

Trainer should preferably be a graduate in veterinary/ animal or agriculture sciences with at least 1 year of experience in the field of teaching/ training.

1.5.7 Local Resource Person (LRP)

LRP can be a village based person passed at least Higher Secondary School Certificate (HSC = 10+2), should preferably be from a family engaged in dairy husbandry with good communication skill, willing to spend required time to implement the program.

1.6 RBP trainings

1.6.4 Training of supervisory officers

RBP training for supervisory officers would be for five days covering class room sessions on RBP software and different aspects of animal feeding. Training template of supervisory officers is given as *Annex. A.*

1.6.5 Training of LRPs

LRPs would be trained on RBP for 10 working days, including 5 days' classroom sessions on basic aspects of animal feeding and software handling and 5 days' field demonstrations. Training template of LRPs is given as *Annex. B.*

1.7 Technical specifications of RBP accessories

Computers/laptops/netbooks and other RBP accessories like ear tags, ear tag applicators, applicator pins, measuring tapes and weighing balances are required to implement RBP. Minimum specifications of above items are given below.

1.7.1 Specifications of computers/laptops/ net books

Desktop/laptop/net books should have below minimum specifications with proper regional settings.

- Processor with Pentium IV and above
- Clock speed with 1.8 GHz and above
- Random Access Memory (RAM) with 512 MB or above
- Hard Disc Drive (HDD) with 40 GB or more
- Two Universal Serial Bus (USB) ports
- Compact Disk (CD) drive with 16x R/W optical drive
- Screen resolution with 1024 x 768 pixels
- Operating system with Windows XP SP – 2 or above

Regional settings in the above hardware to run the software should be as follows:

- English should be of United States (US).
- Time style should be in the format of "h:mm:sstt".
- Short date should be in the format of "M/d/yyyy".
- Date separator symbol should be "/".
- Long date format should be dddd, MMMM dd, yyyy.

1.7.2 Specifications of ear tags

The ear tag is composed of two parts (Male + Female). The male part is a button with a diameter of 27 mm. The male part should have a metal point. The female part is 55 x 65 mm flat surface with a closed head. The tag should be made from Thermoplastic Polyurethane Elastomer material that should be resistant to ultraviolet light, high and low temperature, impossible to reopen by wrench and should be tamperproof.

The weight of the ear tag (male + female) should be 6.5 grams ($\pm$10%). Laser printing of number in two rows of digits with equivalent one dimensional bar code on the first row is must. Numbers and bar code should be big and bold covering full size of the female tag and leaving 2 mm margin on all sides. LIA may provide the list of ear tag numbers to be laser printed on the ear tags. The color of the tags should be lemon yellow. The ear tags should be packed in batches of 100 pieces in a good quality polyethylene bags indicating beginning and ending numbers and further packed in a corrugated box containing 500 pieces of ear tags i.e. 5 polyethylene bags each containing 100 pieces of ear tags.

1.7.3 Specifications of ear tag applicators & pins

Universal ear tag applicators and pins are recommended. An animal ear tag applicator has a jaw with a pivotal pin which can hold the male part of an animal ear tag. It should be sturdy and should not be slippery.

1.7.4 Specifications of measuring tape

Measuring tape should be metal wired, water proof, wear resistant, non-creasing and minimum of five meter in length.

1.7.5 Specifications of weighing balances

Weighing balance should be

- sturdy, accurate, reliable with corrosion protected springs
- lightweight, portable and with protected reading scale
- 5 kg capacity with 25g graduation and 25 kg capacity with 100 g graduation.

1.8 RBP software

1.8.1 An overview of INAPH application

The RBP software is window based internet linked software, which can be loaded in computers, laptops and netbooks. The data recorded through software would be stored in the production server.

Server would be used to record the data of Animal Breeding, Animal Health and Animal Nutrition domains. Main application loaded in laptops/desktops/netbooks would be used for monitoring of RBP by supervisory officers and LRPs to record animal profile, current feeding practices and formulation of balanced ration. The application would require internet connectivity to operate it.

Major steps involved in balancing the ration in INPAH are given below;

- **Registration of animals**: An ear tagged animal will be registered in the software by recording its details like species, breed, age, pregnancy status, body weight, last calving date, milking status etc. The software will validate the entries and register the animal. Such details will be fetched to calculate nutrients requirement of animals.

- **Assessment of nutrients requirement**: Software has the database of the nutrient requirements of various types of animals based on feeding standards commonly followed in developing countries (Annex-C). Total nutrient requirement is assessed for dry matter, crude protein, total digestible nutrients, calcium and phosphorous. Based on animal details provided, the software will assess the nutrients requirement of animals.

- **Assessment of nutrient supply**: Software contains a database of chemical composition of different feed ingredients such as grains, oil cakes/meals, brans, pulse chuni, agro-industrial by-products, green fodders, grasses, crop residues, tree leaves and mineral supplements available across the country (Annex-D). Based on the quantity of different feed ingredients fed to animals, software will fetch the nutrients supplied to the animals in existing feeding system.
- **Formulation of least cost ration using locally available feed ingredients**: Based on nutrients supplied through available feed resources and in accordance with nutrient requirement, software will calculate the deficit or surplus status of nutrients and computes the least cost ration within the given nutritional and available feed resource constraints. In case there is change in feed resources, software can reformulate the least cost ration.

1.8.2 Nutrition Masters

Nutrition masters comprise database of the nutrient requirements of various types of animals. Based on the animal type, body weight and production profile, total nutrient requirement is assessed for dry matter (DM), crude protein (CP), total digestible nutrients (TDN), calcium (Ca) and phosphorous (P).

1.8.3 *Ration Types and their Eligibility Criteria for Animals*

In this program, ration provided to the animals would be of four categories. Animal can be eligible for any one or all of them depending upon the animal profile entered.

1.8.3.1 Maintenance Ration:Every animal is eligible for at least maintenance ration depending upon its type, class and body weight.

1.8.3.2 Milk Production Ration: If animal is producing milk, it is eligible for extra ration over maintenance depending upon the quantity of milk and the percentage of fat in the milk.

1.8.3.3 Growth Ration: An animal is eligible for growth ration equivalent to 20% of maintenance ration, if age of animal is less than or equal to 3 years. If age is > 3 years and <= 4 years, 10% of maintenance ration is permissible. No growth ration is applicable to adult, if animal crosses 4 years of age. Heifers are not eligible for extra growth requirement over maintenance as growth requirement for heifer has already been included in the maintenance requirement.

1.8.3.4 Pregnancy Ration: An animal is eligible for pregnancy ration if the stage of pregnancy is greater than 7 months. The quantity of pregnancy ration depends upon type, Class and body weight of the animal.

1.8.4 *Dry Matter (DM) Intake*

Dry matter intake of the animal is very important for feed formulation. The program sets the DM intake range depending upon the profile of the animal. Criteria used by the software to decide the range of DM intake is as follows.

1.8.4.1 For milking animals,

- If calving month of the animal is <= 2, the DM intake limit would be 2.0 – 2.5% of the body weight.
- If calving month of the animal is > 2 and <= 3, the DM intake range would be 2.0 - 3.0% of the body weight.
- Otherwise it can be between 2.0 - 4.0% of body weight.

1.8.4.2 For Other Animals (Dry/Heifers etc.)

- Dry matter intake range would be 2.0 – 4.0% of body weight.

1.8.5 Dry Matter Ratio from Concentrates and Forages

Feed items listed in the feed library are divided in 2 groups, Concentrates and Forages. The dry matter in the ration comes out from these two groups of items. Ratio of Dry matter quantity from these 2 groups in the ration is very important and decided as follows.

1.8.5.1 For milking animals:

- Milk production up to 5 Kg/day, dry matter from concentrates should be <= 40% of total dry matter in the ration.
- Milk production >5 to <=10 Kg/day, dry matter from concentrates should be <= 50% of total dry matter in the ration.
- Milk production >10 to <=15 Kg/day, dry matter from concentrates should be <= 60% of total dry matter in the ration.
- Milk production >15 to <=55 Kg/day, dry matter from concentrates should be <= 70% of total dry matter in the ration.

1.8.5.2 Other Animals (Dry/Heifers etc.):

- Dry matter from concentrates should be <= 40% of total dry matter in the ration.
- In case, dry matter from concentrates > 60% of total dry matter in the ration, Buffers @ 50-75 g/day should be added along with ration.

1.8.6 Feed library

Feed library consist of different categories of feed ingredients along with its chemical composition used for livestock feeding in the country. The feed library would need to be created to assist the users in finding feed ingredient options for use in their RBP operations. The data shown in the library could be the average values obtained from chemical analysis of representative samples collected from various parts of the country. Library may not include all available feed ingredient options available to livestock producers. Any new feed ingredients available locally can be included in the library after its chemical analysis. A chemical and/or physical analysis of a specific ingredient(s) is always recommended before its entry into software. A brief description of two main classes of feeds is mentioned below.

1.8.6.1 ***Concentrates:*** *In general, feeds having crude fibre (CF) less than 18 per cent while TDN is over 60 per cent on dry matter basis. Usually contain one or more nutrients in a concentrated form. Feed sub-classes under concentrate include brans, pulse chunies, grains/seeds, oil cakes/meals, compound feed, minerals etc.*

1.8.6.2 ***Roughages:*** *Any feed item high in crude fibre (over 18 per cent) and low in TDN (60 per cent) on dry matter basis. Feeds in this class are high in fiber, low in digestible carbohydrates and proteins. Sub classes include grasses, green fodders, tree leaves, straw/stovers, silage, hay etc. which provide bulk to animals.*

1.9 Important guidelines for milk producers on animal feeding and management, meant to be explained by LRPs:

- Chaffing of dry and green fodders before feeding.
- Supplement the ration of dairy animals with recommended quantity of mineral mixture.
- Avoid sudden change in feed ingredients.
- Regular de-worming of animals.
- Fresh and clean water should be available free choice.

- New born calves should be kept in a protected environment and within half an hour of birth, feed colostrum to the calf.

1.10 RBP implementation arrangement

1.10.1 Selection criteria of RBP Lead Implementing Agency (LIA):

1.10.1.1.1 Agency should be willing to implement at least one module of RBP covering 500 breedable animals from 50 contiguous villages.

1.10.1.1.2 Agency should be willing to participate and implement RBP as per the model concept note and guidelines set under NLSIP.

1.10.1.1.3 Agency would recruit a technical officer and requisite number of local resource persons (LRPs), responsible for implementing one module of RBP.

1.10.1.1.4 Agency would provide facility for measurement of milk quantity & fat in the villages covered under RBP.

1.10.1.1.5 Agency would supply quality cattle feed and mineral mixture in the villages covered under RBP on regular basis.

1.10.1.1.6 Agency would provide requisite logistic and other support for implementation and extension of RBP.

1.10.1.1.7 Agency would arrange for requisite RBP implementing accessories like laptops, notebooks, ear tags, applicators, pins, measuring tapes & weighing balances.

1.10.1.1.8 Agency would arrange for translation of RBP extension material in the local language, their printing and distribution in the villages.

1.10.1.1.9 Agency would put in place an information system for collecting data on an individual animal basis and share the requisite data with its stake holders & NLB (Nepal Livestock Board).

1.10.1.1.10 Agency should be able to meet out the expenses of RBP implementation on its own during the project period which could be reimbursed later.

1.10.2 Selection of animals for RBP

It is proposed to consider lactating animals yielding at least 4 litres of milk per day in the initial phase. Later, growing and other category of animals could also be considered under the RBP.

1.10.2.1 Role of NLB*:*

Role of NLB would be to assist technically to the agencies in RBP implementation.

- Provide the software.
- Imparting RBP training to TOs/trainers.
- Providing technical assistance in
  - Preparation of plans of RBP implementation.
  - Procurement of notebooks, laptops & other RBP accessories.
  - RBP software deployment, operation and addressing field issues.
  - Data documentation, analysis and providing technical feedback.

1.11 Role of RBP lead implementing agency:

1.11.1 Implementation of RBP as per the model concept and guidelines set by NLB.

1.11.2 Identification / recruitment of a technical officer and requisite numbers of local resource persons (LRPs) exclusively to implement RBP.

1.11.3 Identify a training centre and trainers required to train LRPs in local language.

1.11.4 Provide necessary logistic & requisite support to technical officer in implementation & monitoring of RBP.
1.11.5 Arrangement of RBP training of technical officer, trainers and LRPs as per the periodic guidelines of NLB.
1.11.6 Arrangement of required quantity of RBP accessories as per the periodic guidelines of NLB and arrange for their stock maintenance.
1.11.7 Ensure ear tagging of animals & regular supply of cattle feed, mineral mixture & other feed supplements in the RBP implemented villages.
1.11.8 Arrangement of internet connectivity, insurance, repair and maintenance of laptops & notebooks.
1.11.9 Translation of RBP extension materials in local language, their printing and distribution in RBP implemented villages.
1.11.10 Provide requisite information to NLB.
1.12 RBP implementation model concepts and guidelines
1.12.1 Lead Implementing Agency (LIA) will implement RBP as per below mentioned model concepts and guidelines.

1.12.1 RBP model concept:

1.12.1.1 One module comprises a contiguous area of 50 villages and 1000 breedable animals, will be the responsibility of one technical officer and 50 LRPs.
1.12.1.2 Each LRP will cover minimum 20 animals per village.
1.12.1.3 50 LRPs identified and trained in1st year will initiate RBP in 50 villages and cover at least 1000 animals in first 12 months.
1.12.1.4 Each LRP will balance the ration for animals and promote sales of feed & feed supplements.
1.12.1.5 Each animal will be revisited once in a month or whenever there is change in feed ingredients and at least 12 ration balancing advices will be given in 12 months.
1.12.1.6 To promote the programme, sustainable allowance of NPR 5000 per month per LRP will be given for three years. During this period, LRPs will provide the ration balancing advices on free of cost. The agency will decide the margin to LRPs on additional sale of feed & feed supplements. It is expected that LRPs will earn at least NPR 3000 per month by sale of feed and feed supplements.
1.12.1.7 Financial outlay required to implement one module of RBP by LIA is mentioned in Annex-E.

1.12.2 Job description of a technical officer:

1.12.2.1 Visit the villages to understand existing feeding pattern, collect the feed samples and arrange for their quality analysis.
1.12.2.2 Prepare RBP implementation plan in consultation with agency.
1.12.2.3 Identify 50 villages and requisite number of LRPs with the assistance of agency.
1.12.2.4 Provide the information required to create user profiles in the ration balancing software to NLB.
1.12.2.5 Prepare the list of requirement of laptops, notebooks & other RBP accessories (ear tags, applicators, pin, measuring tapes of 5 meters & weighing balances of 5 & 25 kg each) to implement one module of RBP and arrange to purchase the accessories with the assistance of agency.
1.12.2.6Arrange for the training of identified LRPs with the assistance of agency.
1.12.2.7 Arrange to provide requisite quantity of RBP accessories to LRPs and maintain the stock records of receipt & issue of RBP accessories.
1.12.2.8 Arrange for insurance, internet connectivity, repair and maintenance of notebooks & laptops with the assistance of agency.

1.12.2.9 Advise LRPs in case of difficulties in ear tagging, conducting farmers meeting, software operation and making least cost balanced ration formulations.

1.12.2.10 Sensitize the agency for regular supply of cattle feed & mineral mixture in RBP implemented villages.

1.12.2.11 Monitor the program by making field visits, farmer meetings and performance review of LRPs on regular interval.

1.12.2.12 Arrange for animal wise data compilation, interpretation & sharing the progress status with agency, LRPs and beneficiaries.

1.12.2.13 Field extension to promote the program and sale of cattle feed & feed supplements in the RBP implemented villages.

1.12.2.14 Arrange to send progress status of the program to NLB as per its requirement.

1.12.3 Job description of a trainer:

1.12.3.1Impart RBP training to LRPs in local language.

1.12.4 Job description of a LRP:

1.12.4.1Participate in the RBP training.

1.12.4.2 Arrange farmer meetings in the identified village(s) to brief the importance of the program and identify the beneficiaries & animals.

1.12.4.3Assist technical officer in collection of feed samples.

1.12.4.4 Ensure proper handling of notebooks & other RBP accessories received.

1.12.4.5 Ear tag the animals, record the animal wise details & their feed intake and formulate the least cost balanced ration.

1.12.4.6 Cross check the information provided by farmers by measuring animal’s body girth, milk yield, milk fat % & quantity of feed ingredients fed to animals.

1.12.4.7 Revisit the animals once in a month or whenever there is change in feed ingredient, formulate fresh ration and ensure feeding of least cost balanced ration by the farmers.

1.12.4.8Ensure to achieve the given targets.

1.12.4.9 Sale cattle feed, mineral mixture & other feed supplements.

1.12.4.10 Provide requisite information to technical officer and follow his/her guidelines.

1.13 Guidelines of RBP implementation

1.13.1 Agency will recruit / identify one technical officer exclusively responsible to implement one module of RBP as per specified job qualification.

1.13.2 Agency will identify trainers, faculty of its own training centre or a local training institution, to train LRPs in local language.

1.13.3 In consultation with NLB, agency will arrange the training of technical officers and trainers on RBP for 5 days as per the training template mentioned in Annex-3.

1.13.4 Trained technical officers will visit villages to understand the existing feeding practices, collect the samples of new feed ingredients and send the samples to National Analytical Lab, Nepal under intimation to LIA.

1.13.5 Technical officers will prepare an action plan of RBP implementation in consultation with agency and send the action plan to NLB.

1.13.6 Technical officers will identify villages to be covered under RBP.

1.13.7 In consultation with agency, technical officers will identify requisite numbers of LRPs as specified in model concepts.

1.13.8 Technical officers will send the information required to create user profiles and organization hierarchy in the ration balancing software as per the formats decided by NLB.

1.13.9 In consultation with NLB, agency will arrange for requisite numbers of notebooks, laptops and other RBP accessories (ear tags, applicators, pins, measuring tapes of 5 meter and weighing balances of 5 & 25 kg).

1.13.10 Agency will arrange for RBP training of LRPs in the identified local training centre as per the training template mentioned in Annex-4.

1.13.11 Agency will provide requisite numbers of notebooks and other RBP accessories to every LRP.

1.13.12 Technical officers will maintain stock record of RBP accessories received/issued.

1.13.13 Technical officers will arrange for internet connectivity, insurance, repair and maintenance of laptops, notebooks with the assistance of agency.

1.13.14 After training, LRPs will initiate the program by conducting village meetings, identifying beneficiaries and animals.

1.13.15 LRPs will ear tag the identified animals, enter the animal wise details & current feeding practices in the software and formulate least cost ration.

1.13.16 LRPs will cross check the information provided by farmers by measuring body girth, milk quantity & fat percent and quantity of feed items fed to animals.

1.13,17 LRPs will revisit the animals once in a month or whenever there is change in feed ingredients and make fresh ration formulations. In addition to ration balancing, they will also sale cattle feed, mineral mixture and other feed supplements.

1.13.18 Agency will ensure regular supply of cattle feed, mineral mixture and other feed supplements in RBP implemented villages.

1.13.19 Agency will provide remuneration and margin on sale of feed and feed supplement to LRPs on every month.

1.13.20 Technical officer will advise LRPs in case of difficulty, meet them on regular interval to review their performance and randomly check the ration formulations made by LRPs.

1.13.21 Technical officer will arrange to compile the animal wise information, analyse the data and send the requisite information to NLB.

1.13.22 Agency will provide necessary logistics and other supports to technical officer in implementation and monitoring of the program.

1.14 Outcome of RBP implementation

1.14.1 It is expected to increase 7-8% milk by implementing RBP in 50 villages covering 500 animals.

1.14.2 As a result of reduction in feeding cost and increase in milk yield and/ fat, farmers will get a net gain of NPR 40-50 per animal per day by implementing RBP.

1.14.3 In addition, other benefits of RBP implementation are as follows:

1.14.4 Awareness amongst the beneficiaries on optimum animal feeding will increase.

1.14.5 Wastage of feed and fodder will reduce.

1.14.6 Improvement in reproductive efficiency of animals.

1.14.7 Reduction in inter calving period, thereby, increase in productive life.

1.14.8 Improvement in general health of animals.

1.14.9 Improvement in animal’s resistance against diseases.

1.14.10 Reduced methane emission in environment.

Glossary of Term

Animal Nutrition - Animal Nutrition is a branch of science which involves physiological and biochemical phenomenon of ingestion, digestion, absorption of various nutrients to all over the body cells and excretion of waste product of metabolism from animal body.

Animal Registration – A written account or entry regarding animal profile and its owner.

Buffer: Any substance that can neutralize changes in acid or alkali concentration. In animal ration it is used to maintain a constant rumen pH when more concentrate ingredients are fed to the animal. E.g. sodium bi-carbonate

Crude Fibre (CF) – The more fibrous, less digestible portion of feed. Consists primarily of cellulose, hemicelluloses and lignin.

Crude Protein (CP) – Crude protein is used to express protein content of feeds (Total Nitrogen x 6.25).

Dry Matter (DM) – Water free portion of the feed. This is sum of the crude protein, crude fat, crude fibre, nitrogen free extract and ash.

Feed - Feeds are any naturally occurring ingredient or material fed to animals for the purpose of sustaining, growth and development.

Inter calving period - Period between two successive calving.

Nutrient – Any chemical compound having specific functions in the nutritive support of animals.

Tag Number – 8 or 12 digit unique numbers used to identify an animal.

TDN – Total digestible nutrients, is the unit of measurement of energy. It is used to express available energy of feeds and energy requirements of animals.

***Annex- A*:**
Training Template for supervisory officers
(TO, Animal Nutritionist & Trainer) of RBP:

SL. No.	Particular	Details
1	Program Title	Training of supervisory officers on ration balancing program (RBP).
2	Program Objectives	To orient the participants on RBP and to acquire knowledge of scientific animal feeding & management for improving productivity and reproduction efficiency.
3	Focus Area	To optimize nutrients' supply through balanced ration, using locally available feed resources.
4	Duration	5 working days.
5	Target Participants	Supervisory officers of RBP
7	Faculty Profile	Post graduate in Animal Nutrition with experience in the relevant field(s).
8	Brief description of course content	Basic aspects of Animal Nutrition; Chemical composition of feeds and fodder; Nutrients requirement for different categories of animals; Significance of area specific mineral mixture, bypass protein and bypass fat supplements. Crop residues management; Importance of green fodder for dairy animals; Possibilities of methane emission reduction through balanced feeding; Disease reporting, bio-security and hygiene. Introduction on RBP; Brief on RBP software and its deployment; Demonstration of RBP software through laptops/net books; Roles & responsibilities of RBP manpower. Practice on RBP software.

***Annex- B*:**

Training Template for Local Resource Persons (LRPs)		
Sl. No.	**Particular**	**Details**
1	Program Title	Training ofLocal Resource Persons implementation of ration balancing program (RBP).
2	Program objectives	To orient the participants on implementation of RBP and to acquire basic knowledge of feeding and management of dairy animals.
3	Focus area	To optimize nutrient's supply through balanced ration, using locally available feed resources.
4	Duration	10 days (5 days' class room & 5 days' field demonstration).
5	Target participants	Supervisors/Local Resource Persons / Sahayaks.
6	Name of the faculty	Identified Trainers/TOs/Animal Nutritionists of the implementing agencies.
7	Faculty profile	Graduate in Veterinary /Animal Science with 3 years' experience in the field of teaching/training or post graduate in Animal Nutrition/Livestock Production and Management with 1 year of experience in the relevant field(s).
8	Brief description of course content	**Class room session:** Basic aspects of feeding and management of animals; Significance of area specific mineral mixture, bypass protein and fat supplements for enhancing productivity; Importance of feeding green fodder to animals. Brief introduction on RBP; Demonstration of RBP software; Roles & responsibilities of Local Resource Persons. Practice on RBP software. Disease reporting, bio-security and hygiene. **Field demonstrations:** Demonstration of ear tagging, measurement of body weight, feeds and fodder etc.; demonstration of ration balancing at farmers' doorstep; Discussions on the difficulties faced during RBP implementation in field and likely the solution.

Annex- C:

Nutrient requirement for maintenance of growing non-pregnant cattle

Species Name	Sex	Adult	Pregnancy status	Weight (kg)	TDN (g)	CP (g)	Ca(g)	P (g)
Cattle	F	N	N	100	1840	421	17	9
Cattle	F	N	N	150	2410	562	19	11
Cattle	F	N	N	200	2950	699	20	14
Cattle	F	N	N	250	3480	718	22	16
Cattle	F	N	N	300	4010	752	23	17
Cattle	F	N	N	350	4560	874	24	18
Cattle	F	N	N	400	5120	1007	25	19
Cattle	F	N	N	450	5710	1151	28	19
Cattle	F	N	N	500	6340	1311	28	20

- *Nutrient requirement for maintenance for large-breed growing females with daily gain @ 600 g has been adopted from NRC (1989), page no. 81.*
- *Values for TDN and CP being lower in ICAR standard and Ca & P values not been given for maintenance, therefore, not considered.*

- *Hence, only NRC (1989) values for maintenance requirement for cattle are adopted.*

Nutrient requirement for maintenance of growing pregnant cattle

Spp.	Sex	Adult	Pregnancy status	Weight (kg)	TDN (g)	CP (g)	Ca(g)	P (g)
Cattle	F	N	Y	250	4176	862	26	19
Cattle	F	N	Y	300	4812	902	28	20
Cattle	F	N	Y	350	5472	1049	29	23
Cattle	F	N	Y	400	6144	1208	30	23
Cattle	F	N	Y	450	6852	1381	34	23
Cattle	F	N	Y	500	7608	1573	34	24

Note: Growing pregnant heifers get 20% extra allowance of maintenance requirement.

Nutrient requirement for maintenance of adult non-pregnant cattle

pp. Name	Sex	Adult	Pregnancy status	Weight (kg)	TDN (g)	CP (g)	Ca (g)	P (g)
Cattle	F	Y	N	300	2620	351	14	9
Cattle	F	Y	N	350	2950	394	16	10
Cattle	F	Y	N	400	3270	436	18	11
Cattle	F	Y	N	450	3580	476	20	13
Cattle	F	Y	N	500	3880	515	23	14
Cattle	F	Y	N	550	4180	553	25	16
Cattle	F	Y	N	600	4470	591	27	17
Cattle	F	Y	N	650	4750	627	30	19
Cattle	F	Y	N	700	5030	663	32	20
Cattle	F	Y	N	750	5310	698	34	21
Cattle	F	Y	N	800	5580	733	36	23

- *TDN & CP requirement adopted from ICAR (2013), page. No. 20. These values are lower side in NRC (1989), hence not considered.*
- *Ca requirement adopted from ICAR (2013), page no, 40. These values being lower in NRC (1989), not considered.*
- *P requirement adopted from NRC (1989). These values are lower in ICAR (2013), hence not considered.*

Nutrient requirement for maintenance of adult pregnant cattle

Spp. Name	Sex	Adult	Pregnancy status	Weight (kg)	TDN (g)	CP (g)	Ca (g)	P (g)
Cattle	F	Y	Y	300	3400	725	20	12
Cattle	F	Y	Y	350	3780	807	23	14
Cattle	F	Y	Y	400	4150	890	26	16
Cattle	F	Y	Y	450	4530	973	30	18
Cattle	F	Y	Y	500	4900	1053	33	20
Cattle	F	Y	Y	550	5270	1131	36	22
Cattle	F	Y	Y	600	5620	1207	39	24
Cattle	F	Y	Y	650	5970	1281	43	26
Cattle	F	Y	Y	700	6310	1355	46	28
Cattle	F	Y	Y	750	6650	1427	49	30
Cattle	F	Y	Y	800	6980	1497	53	32

Note:

- *Nutrient requirement for adult pregnant cattle adopted from NRC (1989).*
- *In ICAR (2013) document, no such values with different body weight for pregnant cattle are given. In view of this, requirements from NRC (1989) have been adopted.*

Nutrient requirement for milk production with different level of fat% for cattle

Spp.	Fat (%)	TDN (g)	CP (g)	Ca (g)	P (g)
Cattle	3.5	**310**	**96**	2.97	1.83

Cattle	3.6	**314**	**96**	3.02	1.86
Cattle	3.7	**318**	**96**	3.07	1.89
Cattle	3.8	**322**	**96**	3.11	1.92
Cattle	3.9	**326**	**96**	3.16	1.95
Cattle	4.0	**330**	**96**	3.21	1.98
Cattle	4.1	**334**	**96**	3.26	2.01
Cattle	4.2	**338**	**96**	3.31	2.04
Cattle	4.3	**342**	**96**	3.35	2.07
Cattle	4.4	**346**	**96**	3.40	2.10
Cattle	4.5	**350**	**96**	3.45	2.13
Cattle	4.6	**354**	97	3.50	2.16
Cattle	4.7	**358**	98	3.55	2.19
Cattle	4.8	**362**	99	3.59	2.22
Cattle	4.9	**366**	100	3.64	2.25
Cattle	5.0	**370**	101	3.69	2.28
Cattle	5.1	**374**	102	3.74	2.31
Cattle	5.2	**378**	103	3.79	2.34
Cattle	5.3	**382**	104	3.83	2.37
Cattle	5.4	**386**	105	3.88	2.40
Cattle	5.5	**390**	107	3.93	2.43
Cattle	5.6	**394**	108	3.98	2.46
Cattle	5.7	**398**	109	4.03	2.49
Cattle	5.8	**402**	110	4.07	2.52
Cattle	5.9	**406**	111	4.12	2.55
Cattle	6.0	**410**	112	4.17	2.58

Note:

- *TDN values for milk production, being slightly higher, with different fat percentage have been adopted from ICAR, 2013.*
- *In ICAR (2013) standard, crude protein value for milk production is same at. 96 g /kg milk, for different levels of fat%. As values for crude protein per kg of milk production with fat >4.5% under NRC (1989) are higher than ICAR standard. Hence, crude protein values have been adopted from NRC (1989) for milk production with fat % higher than 4.5.*
- *Ca and P values for per kg milk production have been taken from NRC (1989). These values are lower and same for different level of fat% i.e. Ca: 3.2 g/kg milk production and P: 1.8 g/kg milk production.*

(Bold values from ICAR (2013) and other values from NRC (1989).

***Annex*- D**

Chemical composition of feeds and fodder (on DM basis)

Particular	**DM (%)**	**CP (%)**	**TDN (%)**	**Ca (%)**	**P (%)**
Grains and seeds					
Wheat	90	11.11	86.67	0.06	0.36
Bajra	90	12.00	75.56	0.13	0.51
Black gram	90	28.78	77.78	0.16	0.37
Jowar/Sorghum	90	8.70	83.33	0.04	0.34
Rice	90	9.02	82.22	0.03	0.36

Maize	90	9.00	88.89	0.02	0.46
Cakes/ Meals					
Rapeseed meal	90	42.22	77.78	1.11	1.12
Rapeseed cake	90	38.63	82.22	1.08	1.24
Sunflower meal	90	31.11	66.67	0.51	1.24
Sunflower cake	90	25.56	72.22	0.47	1.22
Soybean meal	90	53.33	83.33	0.33	0.83
Guar korma	90	54.44	83.33	0.56	0.60
Cotton seed meal	90	41.33	83.33	0.31	0.87
Cotton seed cake (Undecorti)	90	24.44	78.89	0.20	0.46
Coconut meal	90	30.00	72.78	0.22	0.67
Coconut cake	90	26.00	100.11	0.44	0.82
Groundnut meal	90	48.89	80.00	0.28	0.79
Groundnut cake	90	46.44	87.67	0.22	0.67
Green fodder					
Bajra/ small millets	20	6.90	59.40	0.60	0.21
Berseem	18	16.00	59.60	1.66	0.30
Cowpea	18	28.10	58.90	1.43	0.30
Guinea grass	20	11.70	53.90	0.64	0.32
Napier (Elephant grass)	20	6.20	55.40	0.50	0.27
Napier (Hybrid)	20	11.50	60.00	0.68	0.32
Para grass	20	12.00	59.50	0.36	0.19
Horse gram	18	14.70	51.80	1.36	0.23
Sorghum	20	7.80	53.90	0.39	0.33
Lucerne	18	17.00	60.20	1.94	0.35
Maize	20	7.60	65.00	0.68	0.21
Oat	20	10.80	60.00	0.43	0.26
Paddy	20	5.80	60.00	0.31	0.28
Sunflower	20	11.00	52.50	0.96	0.24

Annex D Continue……					
PARTICULAR	**DM (%)**	**CP (%)**	**TDN (%)**	**Ca (%)**	**P (%)**
Straws					
Bajra straw	90	3.44	53.33	0.43	0.18
Sorghum straw	90	4.11	55.56	0.62	0.12
Maize Stover	90	4.00	50.00	0.50	0.19
Paddy straw	90	3.22	44.44	0.40	0.11
Wheat straw	90	3.67	51.00	0.44	0.13
Pulse straw (Residue)	90	5.00	50.00	2.00	0.20
Brans / fodder					
Maize bran	31	11.00	60.00	0.40	0.70
Wheat bran	90	16.89	66.67	0.24	1.22
Rice bran	90	14.44	88.89	0.11	2.09
Rice bran (De-oiled)	90	17.78	61.11	0.11	1.78
Cattle Feed	90	20.00	62.00	1.00	1.00
Anjwan leaves	20	12.00	50.00	1.20	0.40
Banana flowers	10	20.00	64.00	0.50	0.30

Banana leaves	10	12.00	64.00	1.40	0.10
Banana roots	10	12.00	60.00	0.70	0.20
Banana suckers	10	12.00	64.00	0.90	0.20
Barley sprout	26	22.00	65.00	0.40	0.40
Sugarcane leaves	25	3.00	50.00	0.63	0.16
Whole sugarcane	35	2.00	55.00	0.50	0.10

Annex-E: Proposed financial outlay required to implement one module of RBP

Sl. No	Expenses	Unit cost (NPR)	Unit (No.)	First year	Second year	Third year	Fourth year	Total (NPR)
I	**TO remuneration**				(NPR)	(NPR)	(NPR)	
1	Salary and other benefits (per month)	80,000	1	960000	960000	960000	960000	3840000
2	TA & other expenses (per month)	20000	1	20000	20000	20000	20000	80000
II	**RBP Training**							
1	LRP	10000	50	500000				500000
2	TO	15000	1	15000				15000
3	Trainer	15000	2	30000				30000
III	**RBP accessories**							
1	Laptop to TO	60,000	1	60000				60000
2	Notebook to LRPs & TO	15000	52	780000				780000
3	Ear-tag	15	500	7500				7500
4	Ear-tag applicator	100	55	5500				5500
5	Applicator pin	50	55	2750				2750
6	Measuring tape (5 meter)	500	55	27500				27500
7	Spring balance 5 Kg	500	55	27500				27500
8	Spring balance 25 Kg	1000	55	55000				55000
IV	**RBP promotion**							
1	Vehicle hiring (per month)	15000	1	180000	180000	180000	180000	720000
2	Sustainable allowance to LRP	5000	50	3000000	3000000	3000000	3000000	12000000
3	Prize distribution to farmers	2500	50	125000				125000
4	Pamphlet	50	1000	50000				50000
5	Wall painting	500	50	25000				25000
6	Poster	100	100	10000				10000
V	**Miscellaneous**							
1	Feed sample testing	5000	100	500000	500000			1000000
2	User charges - TO	500	1	500	500	500	500	2000
3	User charges - LRP	300	50	15000	15000	15000	15000	60000
4	Insurance	500	50	25000	25000	25000	25000	100000
5	Repair & maintenance	1000	50	50000	50000	50000	50000	200000
6	Stationary & others	500	50	25000	25000	25000	25000	100000
Total								19822750
Say								**198 lakh**

Organogram of Ration Balancing Program Implementation

Project Coordinator (1 per Lead Implementing Agency)	Technical officer (1 per 50 villages)
Local Resource Person (1 per village)	Trainer (2 per 50 villages)

Chapter 2

Production and Distribution of Mineral Mixture

2.1 INTRODUCTION

2.1.1 Most of the field animals in Nepal suffer from mineral deficiencies at clinical and sub-clinical level. As a result, milk/wool production is low and the reproduction is severely affected. There is hardly any mineral mixture plant in the whole country. Very little quantity of mineral mixture is imported and sold at exorbitantly higher prices. It is proposed that four mineral mixture plants will be set in project districts for production and distribution of mineral mixture suitable for livestock, considering the agro-climatic and feeding conditions.

2.1.2 Livestock requires a number of dietary mineral elements for normal body maintenance, growth and reproduction. Minerals that are required in relatively large amounts are called major or macro elements. Those needed in small amounts are classified as micro, minor, or trace minerals. The major minerals include calcium, phosphorus, magnesium, potassium, sodium, chlorine and sulphur. Among those needed in trace amounts are iron, zinc, manganese, copper, iodine, cobalt and selenium. Deficiency of minerals in the ration of animals impairs metabolic functions, which affects the growth in young calves and milk production and reproduction efficiency in adult animals. Supplementation of bio-available minerals through mineral mixture is of paramount importance, as minerals are nowhere synthesized in animal's body.

2.2 FUNCTIONS OF DIFFERENT MINERALS

2.2.1 Calcium (Ca):

- Essential for milk production.
- Necessary for bone & teeth formation.
- Required for contraction of muscles.

2.2.2 Phosphorus (P)

- Essential for milk production.
- Required in energy metabolism.
- Required for bone & teeth formation.

2.2.3 Magnesium (Mg)

- Important for the integrity of bone & teeth.
- Involved in protein synthesis and metabolism of carbohydrates & lipids.

2.2.4 Sulphur (S)

- Required for protein synthesis and metabolism of carbohydrates & lipids.
- Sulphur is a part of B-complex vitamins, thiamin & biotin.

2.2.5 Sodium (Na) & Potassium (K)

- Required for maintenance of osmotic balance.
- Required in acid- base equilibrium.

2.2.6 Copper (Cu)

- Required for haemoglobin synthesis.

- Necessary for tissue pigmentation & component of several metallo-enzymes.
- Required for normal reproduction functions.

2.2.7 Zinc (Zn)

- Spermatogenesis & the development of primary & secondary sex organs.
- Required for normal functioning of epithelial tissue.
- Activates vitamin A & its deficiency leads to night blindness.

2.2.8 Manganese (Mn)

- Co-factor for many enzymes involved in carbohydrate metabolism.
- Activator in the synthesis of fatty acids.

2.2.9 Iodine (I)

- Required for the synthesis of thyroid hormone (T_3& T_4).
- Necessary for reproduction & growth of animals.

2.2.10 Cobalt (Co)

- Required for the synthesis of vitamin B_{12} by the rumen microbes.
- Essential for haemoglobin synthesis.

2.2.11 Chromium (Cr)

- Required for the synthesis and metabolism of carbohydrates, protein and fat.
- Essential for improvement of immune status.

2.3 HOW TO PRODUCE GOOD QUALITY MINERAL MIXTURE

2.3.1 Mineral mixture is manufactured using di-hydrate di-calcium phosphate (DCP) of rock phosphate origin and dried/ monohydrate mineral salts.

2.3.2 Dried/monohydrate mineral salts are crushed and mixed to a uniform particle size, using proper diluents, in a separate device, called ball mill.

2.3.3 This trace mineral pre mix is taken in the ribbon mixer, along with DCP and few other mineral salts, for proper dispersion and uniform mixing.

2.3.4 The resultant mineral mixture thus produced contains all mineral elements in desired proportion and stable form.

2.3.5 Mineral mixture should not contain any ingredient of animal origin, even in traces.

2.4 MINERAL SALTS USED IN MINERAL MIXTURE

2.4.1 Di-calcium phosphate, Animal Feed Grade
2.4.2 Calcite powder
2.4.3 Magnesium oxide
2.4.4 Sodium thio-sulphate
2.4.5 Copper sulphate
2.4.6 Copper glycinate
2.4.7 Zinc sulphate
2.4.8 Zinc glycinate
2.4.9 Manganese sulphate
2.4.10 Manganese glycinate
2.4.11 Cobalt sulphate

2.4.12 Chromium chelate
2.4.13 Ferrous sulphate
2.4.14 Potassium iodide

2.5 MINERAL MIXTURE FORMULATION

2.5.1 Minerals that are not sufficient from the feeds and fodder ingested by the animals only need to be supplemented through mineral mixture.
2.5.2 Mineral mixture should supply only those minerals that are deficient in the ration.
2.5.3 Mineral mixture need to be formulated, based on the minerals that are deficient in the feeds and fodders that are commonly fed to livestock in different regions of Nepal. Supplementation of mineral mixture helps in improving growth, general health, milk production and reproduction efficiency of dairy animals; meat and wool production in small ruminants like sheep and goat.

2.6 DIRECTIONS FOR USE

2.6.1 Milch cows
100-200g daily, depending upon level of milk production.
2.6.2 Growing and non-producing animals
50g daily per animal.
2.6.3 Young calves
20-25 g daily for better weight gain.
2.6.4 Small ruminants (sheep/goat)
15-20 g daily for improved growth and wool yield.

2.7 MODE OF FEEDING MINERAL MIXTURE

2.7.1 Mineral mixture can be fed by mixing it with concentrate mixture or by mixing 15-20 g common salt to it.
2.7.2 Usually, compound cattle feed contains mineral mixture at varying levels, however, additional requirement can be met by mixing it with feed.

2.8 BENEFITS OF FEEDING MINERAL MIXTURE

2.8.1 Improves growth rate of calves, hence early puberty.
2.8.2 Improves reproduction efficiency in male and female animals.
2.8.3 Reduces inter-calving period, more productive life of animals.
2.8.4 Improves efficiency of feed utilization.
2.8.5 Improves milk production.
2.8.6 Better immune response; hence better resistance against infectious diseases.
2.8.7 Calves born are healthy.
2.8.8 Improves general health of animals.

2.9 PRODUCTION AND DISTRIBUTION OF MINERAL MIXTURE

2.9.1 Most of the field animals suffer from mineral deficiencies at clinical and sub-clinical level. 2.9.2 As a result, milk/wool production is low and the reproduction is severely affected.
2.9.3 There is hardly any mineral mixture plant in the whole country.
2.9.4 Very little quantity of mineral mixture is imported and sold at exorbitantly higher prices.
2.95 It is proposed that four mineral mixture plants will be set in project districts for production and distribution of mineral mixture suitable for livestock, considering the agro-climatic and feeding conditions.

2.10 **ESTIMATED COST OF MINERAL MIXTURE PLANT (CAPACITY: 12 MTPD)**

Sl. No.	**Equipment**	**Qty.**	**Unit**	**Electrical load**	**Total value (NPR)**
1.	Supply of mineral mixture plant consisting of stainless steel ribbon blender, conveying system, storage silos, SS ball mill and control panel etc.	1	Lot	40 HP	50,00,000
2.	Transportation, taxes, duties, insurance and procurement & service charges etc. on supply of equipment	1	LS		
3	Erection, testing & commissioning of plant	1	LS		
NPR: Nepalese Rupees					

2.11 ASSUMPTIONS FOR ESTIMATED COST OF MINERAL MIXTURE PLANT

Sl. No.	**Description**
1.0	Estimate is made for 12 MT / Day production of mineral mixture meal.
2.0	Size of godown required for storage of raw materials and finished product is 40 M (L) x 25 M (W) X 6 M (H). This includes the space required for setting up the plant which is approx. 10 M x 4 M x 5 M (minimum height).
3.0	Total power required is 40 HP.
4.0	**The followings are not considered in the estimate:**
4.1	Raw materials, consumables and packing materials etc. for production of mineral mixture.
4.2	Charges for getting incoming power at MCC of the mineral mixture plant.
4.3	Cost for constructing the godown and its RCC flooring.
5.0	Approximate time required for setting up the plant is 2 to 3 months after placement of firm order.
6.0	**The following facilities are to be provided by the project authority:**
6.1	For plant installation, storage of raw material and finished products godown size of approx. 40mt x 25 or 15mt. x 6 mt. height is required
6.2	Incoming power 40 HP supply to control panel of mineral mixture plant.
6.3	100/200kg & 10kg weighing machine for bag/pouch weighing.
6.4	Suitable earth pit to connect all earth points.
6.5	Raw materials such as Di-calcium phosphate, Calcite powder, Magnesium oxide, Trace minerals and other consumables.
6.6	Road permit/waybill and other documents for transporting & raise tax invoice of equipment (whenever need by supplier)
6.7	Complete address, where the plant is to be supplied by the supplier

6.8	1) 1kg packaging—HMHD bag, size 28cm x 17cm x 0.07 to 0.08mm thickness. Hand operated heat sealing machine for mouth seal is required. 2) Secondary packaging for 10 packets of 1kg each – use corrugated box(3ply) suitable size, it is easy to handle box of 10 kg, in place of 25 kg. 3) 1kg packaging—HMHD (D-punched) carry bag, size 32cm x 20cm x 0.07 to 0.08mmthickness. Hand operated heat sealing machine for mouth seal is required. 4) 5 kg packaging- HDPE woven sack bag with inner plastic lamination, size 40cm x 30cm (require hand stitching machine for mouth stitch) 5) 10 kg packaging- HDPE woven sack bag with inner plastic lamination, size 65cm x 34cm (require hand stitching machine for mouth stitch)

2.12 PROJECTED VIABILITY OF A 12 MTPD MINERAL MIXTURE PLANT

PARTICULARS	PARAMETER (NPR/MT)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Capacity Utilisation		33%	66%	100%	100%	100%	100%	100%	100%	100%	100%
Annual Production - 300 days (MT)		1188	2376	3600	3600	3600	3600	3600	3600	3600	3600
		Amount in NPR Lakh									
Sales Realisation	53526	963	1445	1927	1927	1927	1927	1927	1927	1927	1927
Formula Cost	40000	720	1080	1440	1440	1440	1440	1440	1440	1440	1440
Cost of Power	400	7	11	14	14	14	14	14	14	14	14
Packing Cost (50% 1Kg; 50% 25 Kg)	2500	45	68	90	90	90	90	90	90	90	90
Commission	10000	180	270	360	360	360	360	360	360	360	360
Labor Cost (NPR 500/ Head/shift: 5 labor)	@NPR 500/day	2	8	2	2	2	2	2	2	2	2
Supervisor (NPR 10000/month/shift)		2	2	2	2	2	2	2	2	2	2
Total Costs		956	1438	1908	1908	1908	1908	1908	1908	1908	1908
Operating Profit		7	8	18	18	18	18	18	18	18	18
Depreciation - WDV @ 20% p.a.		10	8	6	5	4	3	3	2	2	1
Interest on Working capital		4	4	4	4	4	4	4	4	4	4
Interest @11% p.a.		6	6	6	5	4	3	3	2	1	1
Working of DSCR											
Cash Generated		-2	-2	9	10	11	11	12	13	14	14
Interest on Term Loan		6	6	6	5	4	3	3	2	1	1
	127	**4**	**4**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
Repayment											
Interest		6	6	6	5	4	3	3	2	1	1
Principal		0	0	6	6	6	6	6	6	6	6
	86	**6**	**6**	**12**	**11**	**10**	**10**	**9**	**8**	**8**	**7**
DSCR (Debit service coverage ratio)	**1.5**	**0.7**	**0.7**	**1.3**	**1.3**	**1.4**	**1.5**	**1.7**	**1.8**	**2.0**	**2.1**

ROI (Return on investment)										
Investment	**500**	50	50	50	50	50	50	50	50	50
PAT + Interest	**82**	-6	-4	8	10	11	12	12	13	13	14
	16%									
Investment		**50.0**								
Total Cost per MT	53326	53986	53744	53343	53288	53241	53199	53162	53128	53097	53069
<u>Depreciation</u>											
Opening Balance		0	40	32	26	20	16	13	10	8	7
Additions		50	0	0	0	0	0	0	0	0	0
Depreciation	**20%**	10	8	6	5	4	3	3	2	2	1
WDV (Written Down Value)		40	32	26	20	16	13	10	8	7	5
<u>Interest & Repayment</u>											
Opening Balance		0	50	50	44	38	31	25	19	13	6
Disbursed		50									
Repayment				6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Closing Balance		50	50	44	38	31	25	19	13	6	0
Interest	11%	5.5	5.5	5.5	4.81	4.12	3.43	2.75	2.06	1.35	0.68

2.13 ANALYSIS OF PROJECTED VIABILITY OF MINERAL MIXTURE PLANT

2.13.1 Mineral mixture plant (MMP) Capacity 12 MTPD.

2.13.2 Cost of mineral mixture plant is considered at NPR 50,00,000/- including machinery cost, taxes,installation, commissioning. This does not include cost of building, raw material and finished product godown. In addition, electric power cable would need to be provided by the project authority to man control panel of mineral mixture plant.

2.13.3 Mineral mixture plant capacity utilisation at 33% in 1st year, 66% in 2nd year and 100% from 3rd year onwards

2.14 COMPONENTS OF MINERAL MIXTURE PLANT

2.14.1 The mineral mixture plant has been designed in two sections. In first section, predetermined quantities of trace mineral salts of desired quality are crushed into fine powder form in a ball mill of capacity 500ltrs.

2.14.2 In the second section, crushed mineral salts (trace elements) are thoroughly mixed with other ingredients viz. calcite powder, magnesium oxide, sodium thio-sulphate and di-calcium phosphate in a ribbon mixer and conveyed through screw conveyor to a storage silo.

2.14.3 The mineral mixture plant consists of the following major equipment, duly mounted on a self-supported skid.

2.14.3.1 Ball Mill: In the ball mill, predetermined quantities of trace mineral salts, as specified in table C, are poured in the ball mill drum for grinding. The mixture is then crushed into fine powder form in minimum 1-1.5 hours' time. The ball mill shall be of 500 lit. capacity. SS 304 rotating drum with minimum 60 kg of EN-31 balls of 50 mm dia. Approx. 120 balls are required for crushing the granules to such an extent that 90% of crushed powder should pass through 212 microns IS sieve. The crushed powder shall be collected in 50 kg bags manually.

2.14.3.2 Intake Inclined Screw Conveyor: Di-calcium phosphate (DCP), magnesium oxide (MgO), calcite powder and Sodium thio-sulphate along with the trace minerals pre-mix shall be dumped into the hopper mounted on the conveyor to feed the ribbon mixer with the desired quantity.

2.14.3.3 Ribbon Mixer: The ribbon mixer has a rated capacity of 500 kg. However, it is designed to handle maximum 700 kg, which is 40% higher than the rated capacity. It has provision for forward and reverse rotation of the ribbon shaft for thorough mixing of various mineral salts and premix, in maximum 20-minutes time.

2.14.3.4 Silo Inclined Screw Conveyor: The hopper of the conveyor receives the thoroughly mixed mineral mix powder from the ribbon mixer bottom outlet. The conveyor of 2.0 MT /hr capacity, transfers the powder to storage silo.

2.14.3.5 Storage Silo: The SS 304 storage silo of 700 kg capacity functions as an intermediate storage till the mixed mineral powder is packed in 50/25 kg bags. The silo has a top inlet and a bottom outlet, provided with manually operated slide gate valve and motor operated bin discharger.

2.15 INSTALLATION INSTRUCTIONS

2.15.1 Ball mill and mineral mix plant are skid mounted type construction and hence no major installation work at site is involved. The project authority shall arrange for electrical supply to the control panel of the mineral mix plant and ball mill. Cabling from control panel to the individual drive is the responsibility of the supplier.

2.16 TESTING OF THE PLANT

2.16.1 Generally, the plant is thoroughly tested during the fabrication stage. However, once the installation at site is completed, the total plant is again tested with proper mineral salts. Start up and shut down procedure given below should be followed.

2.17 START UP AND SHUT DOWN PROCEDURE

2.17.1 Ball Mill

2.17.1.1 Check the correct level of oil in the gear box.

2.17.1.2 Check the correct direction of rotation of the ball mill drum.

2.17.1.3 Open anyone hand hole cover. Ensure that the hand hole cover on the other side is fully tight.

2.17.1.4 Remove the cover, place 120 nos. En-31, 50 mm dia. balls inside the drum.

2.17.1.5 Load the drum with appropriate quantity of trace element pre-mix.

2.17.1.6 Close the hand hole cover fully tight and close the ball valve mounted on the cover.

2.17.1.7 Close the hinge cover of the SS shroud.

2.17.1.8 Now switch on the ball mill. Ensure that it rotates clockwise if viewed from the motor side.

2.17.1.9 Initially operate for an hour, stop the switch and open the hinge cover of the shroud.

2.17.1.10 Slowly open the ball valve of the hand hole and see if any pressure releases from the drum. Sometimes the ball valve gets choked with the fine mineral mix powder. Insert a rod through the ball valve opening and ensure that there is no choking in the ball valve and that all the pressure build up inside the drum has been released through valve.

2.17.1.11 Open any one hand hole cover by loosening the opposite side nuts and then remove the cover from the drum.

2.17.1.12 Take a sample and see the fineness of the powder. If the desired fineness is not achieved, tighten the hand hole cover, close the ball valve and run the ball mill for one more hour. The ball mill is designed to crush the batch in maximum 4 hours' time. However, depending upon the granule size available and the moisture content, the time can be standardised by hit and trial method, which could be from 1 to 2 hours.

2.17.1.13 Once the desired fineness is achieved, remove the hand hole as mentioned earlier.

2.17.1.14 Place SS grill cover on the hand hole and tighten it fully and then close the hinge cover of the shroud.

2.17.1.15 Place an empty bag fastened by hooks below the shroud discharge valve and then open the discharge flap valve.

2.17.1.16 For decanting, start rotating the drum by putting the switch ON.

2.17.1.17 Once the total crushed powder is collected in the bags, stop ball mill and bring the grilled hand hole position on top.

2.17.1.18 Remove the grilled cover, re-charge the drum with fresh ingredients and close the hand hole cover.

2.17.1.19 Repeat the process till the complete batch is crushed to the desired fineness.

2.17.1.20 Once the batch is over and the ball mill is not required to operate for quite some time, ensure that the drum is completely emptied and the hand hole cover is closed.

2.17.1.21 Switch off the main switch.

2.18 MINERAL MIXTURE PLANT

2.18.1 Check the correct level of oil in the gearbox of ribbon mixer, intake inclined screw conveyor, silo inclined screw conveyor, bin discharger.

2.18.2 Check the correct direction of rotation of the ribbon mixer and screw conveyors.

2.18.3 Manually close the ribbon mixer bottom outlet.

2.18.4 Put ON the intake inclined screw conveyor and ribbon mixer. In the auto mode the ribbon mixer will run in forward and reverse direction for a pre-set time.

2.18.5 Start dumping all ingredients in the hopper of intake inclined screw conveyor.

2.18.6 Run the ribbon mixer in auto mode for 15 minutes.

2.18.7 The mixer is set for forward and reverse rotation in auto mode and will mix all the ingredients thoroughly.

2.18.8 Close the discharge valve of the storage silo and start the silo inclined screw conveyor to transfer mineral mix powder from ribbon mixer to silo.

2.18.9 Put the ribbon mixer in the forward rotation mode and open the bottom discharge valve of the ribbon mixer.

2.18.10 Mineral mixture will start pouring into the small hopper of silo inclined screw conveyor and convey to the storage silo.

2.18.11 At the end when material stop coming out from the outlet valve, quench the ribbon mixer by reverse & forward operation for some time so that all the powder drops into the hopper of silo inclined screw conveyor.

2.18.12 Close the bottom outlet valve of the ribbon mixer.

2.18.13 With a time lapse, stop the silo inclined screw conveyor. Repeat the procedure for next batch.

2.19 CLEANING PROCEDURE

2.19.1 The ribbon mixer can be emptied completely by quenching in forward and reverse movement. The left over can be cleaned with brush.

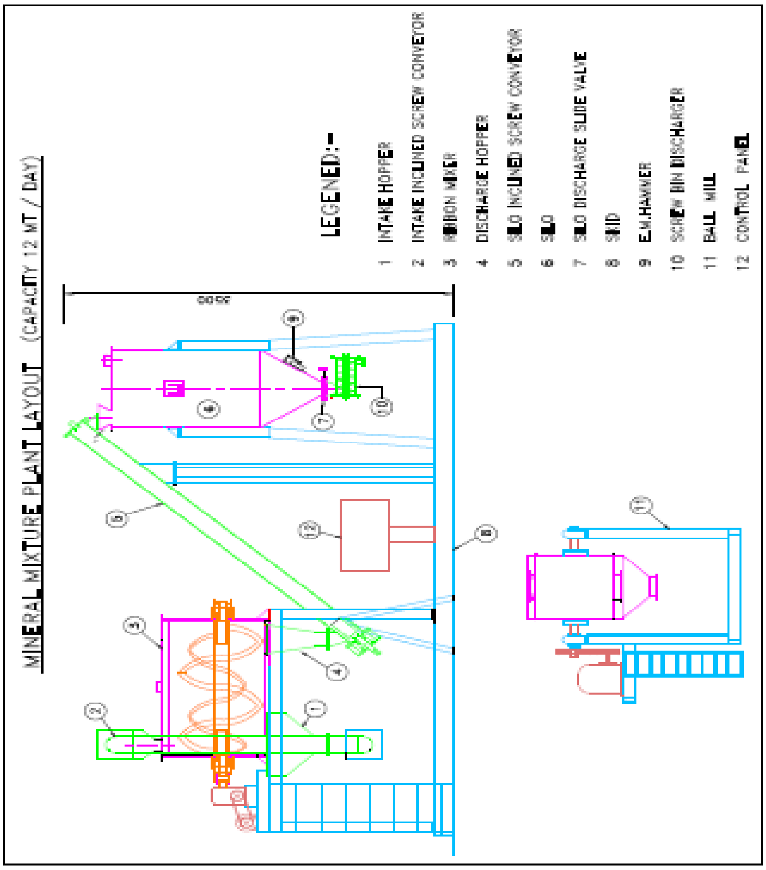
2.19.2 In the intake feed screw conveyor and silo inclined screw conveyor, a hinge door has been provided at the lowermost portion of the conveyor.

2.19.3 By partially opening the hinge door, the accumulated material in the screw conveyor can be collected in the bag. Initially the material will fall down by gravity, entire material can be removed by quenching the screw in the forward direction.

2.19.4 Silo is an intermediate storage facility before bagging the entire batch. However, it should not be used as storage for longer period. The mineral mix has tendency to absorb moisture if it is exposed to atmosphere for long time.

2.19.5 If the mineral mix remains in silo for long it might absorb atmospheric moisture and chances of material choking the silo increases. Hence, mineral mix should be transferred to bags immediately and not stored in silo for long.

2.20 LAY OUT PLAN OF MINERAL MIXTURE PLANT, 12 MTPD



2.20 SAFETY ASPECTS RELATED TO MINERAL MIXTURE PLANT

2.21.1 Requirement

- Face shield or goggles to protect the face and eyes
- Hand gloves
- Face mask
- Gumboots and impervious apron
- Good quality barrier cream for skin
- Emergency face/eye washer and shower

2.21.2 Protective clothing and equipment

- Wear a laboratory coat and gloves when handling mineral salts.
- Face shield or goggles to protect the face and eyes from splashes should be worn when mixing or handling fine mineral salts.
- Apply a good quality barrier cream on hands and forearms to prevent dermatitis and general skin irritation, after handing of mineral salts.

2.22 ENVIRONMENTAL ASPECTS RELATED TO MINERAL MIXTURE PLANT AND EMPLOYMENT TO RURAL WOMEN

2.22.2 There is no any effluent from mineral mixture plant, so setting up mineral mixture plants have no adverse effect on the environment.

2.22.3 Use of mineral mixture on wider scale helps in reducing methane emission, as feed utilization efficiency will increase, esp. on crop residues based diet in a developing country like Nepal.

2.22.4 Sale of mineral mixture through rural women will provide them an employment opportunity and could be a significant source of disposable income for them in the rural areas in different parts of project districts of Nepal.

Annex-A

Specifications for mineral mixture (plain) for Nepal

Sl. No.	Particular	**Requirements**
1.	Moisture (%), Max.	5.0
2.	Calcium (%), Min.	20.0
3.	Phosphorus (%), Min.	12.0
4.	Magnesium (%), Min.	4.0
5.	Sulphur (%)	2.0-3.0
6.	Copper (%), Min.	0.12
7.	Zinc (%), Min.	1.30
8.	Cobalt (%), Min.	0.012
9.	Iodine (%), Min.	0.026
10.	Chromium (%), Min.	0.004
11.	Manganese (%), Min	0.12
12.	Iron (%), Min.	0.40
13.	Fluorine (%), Max.	0.07
14.	Lead (mg/kg), Max.	30
15.	Arsenic (mg/kg), Max.	10

Ingredient composition of mineral mixture (plain)

Mineral element	**%**	**Name of the mineral salt**	**Quantity (kg/100 kg)**
Calcium	20.0 (Min.)	Di-calcium phosphate (Ca: 23% Min.)	66.667
		Calcite powder (Ca: 37% Min.)	14.118
Phosphorus	12.0 (Min.)	Di-calcium phosphate (P: 18% Min.)	--
Magnesium	4.0 (Min.)	Magnesium oxide (Mg: 52% Min.)	7.692
Sulphur	2.0 (Min.)	Sodium thio-sulphate (S: 39% Min.)	5.128
Copper	0.12 (Min.)	Copper sulphate (Cu: 24% Min.)	0.480

Zinc	1.30 (Min.)	Zinc sulphate (Zn: 33% Min.)	3.939
Cobalt	0.012 (Min.)	Cobalt sulphate (Co: 20% Min.)	0.06
Chromium	0.004 (Min.)	Chromium chelate (Cr: 8% Min.)	0.05
Manganese	0.12 (Min,)	Manganese sulphate (Mn: 31% Min.)	0.387
Iron	0.40 (Min.)	Ferrous sulphate (Fe: 30% Min.)	1.333
Iodine	0.026 (Min.)	Potassium iodide (I: 75% Min.)	0.035
Sucram (Sweetening agent)			0.02
Lacto-vanilla coconut (Flavoring agent)			0.02
Total			**100.00**

Specifications for chelated mineral mixture for Nepal

Sl. No.	Particular	**Requirements**
1.	Moisture (%), Max.	5.0
2.	Calcium (%), Min.	20.0
3.	Phosphorus (%), Min.	12.0
4.	Magnesium (%), Min.	3.0
5.	Sulphur (%)	2.0-3.0
6.	Copper (%), Min.	0.12
7.	Zinc (%), Min.	1.30
8.	Cobalt (%), Min.	0.012
9.	Iodine (%), Min.	0.026
10.	Chromium (%), Min.	0.004
11.	Manganese (%), Min	0.12
12.	Iron (%), Min.	0.40
13.	Fluorine (%), Max.	0.07
14.	Lead (mg/kg), Max.	30
15.	Arsenic (mg/kg), Max.	10

Ingredient composition of chelated mineral mixture

Mineral element	**%**	**Name of the mineral salt**	**Quantity (kg/100 kg)**
Calcium	20.0 (Min.)	Di-calcium phosphate (Ca: 23% Min.)	66.667
		Calcite powder (Ca: 37% Min.)	13.381
Phosphorus	12.0 (Min.)	Di-calcium phosphate (P: 18% Min.)	--
Magnesium	4.0 (Min.)	Magnesium oxide (Mg: 52% Min.)	5.769
Sulphur	2.0 (Min.)	Sodium thio-sulphate (S: 39% Min.)	5.128
Copper	0.06 (Min.)	Copper sulphate (Cu: 24% Min.)	0.240
	0.06 (Min.)	Copper glycinate (Cu: 15% Min	0.400
Zinc	0.65 (Min.)	Zinc sulphate (Zn: 33% Min.)	1.970

	0.65 (Min.)	Zinc glycinate (Zn: 15% Min.)	4.333
Cobalt	0.012 (Min.)	Cobalt sulphate (Co: 20% Min.)	0.06
Chromium	0.004 (Min.)	Chromium chelate (Cr: 8% Min.)	0.05
Manganese	0.06 (Min,)	Manganese sulphate (Mn: 31% Min.)	0.194
	0.06 (Min.)	Manganese glycinate (Mn: 15% Min.)	0.400
Iron	0.40 (Min.)	Ferrous sulphate (Fe: 30% Min.)	1.333
Iodine	0.026 (Min.)	Potassium iodide (I: 75% Min.)	0.035
Sucram (Sweetening agent)			0.02
Lacto-vanilla coconut (Flavoring agent)			0.02
Total			**100.00**

Chapter 3

Production Process of Urea Molasses Mineral Block Licks by Modified ‘Cold Process’

3. INTRODUCTION

3.1 The productivity of dairy animals in developing countries is greatly constrained by the lack of green fodder and good quality feed, due to availability and cost reasons. Like other tropical and sub-tropical countries, bulk of basal ration of livestock in Nepal comes from crop residues, which are deficient in fermentable carbohydrates, nitrogen and minerals. As a result, feed intake is low and utilization of crop residues in the rumen is poor as rumen microbes don’t get required nutrients for their growth from the basal ration.

3.2 Since molasses are available in plenty in Nepal, especially in terai region, it is suggested that four plants will be set up in terai region of project districts for production of urea molasses mineral block (UMMB) lick. Each block could be of 3 kg that would last for about a week. Animals fed on crop residues based diets will be supplemented UMMB. By doing so, it should be possible to save concentrate used for feeding body maintenance. It will be specifically very useful for animals producing 2-5 litres milk per day, especially during lean periods when no green fodder is available during the lean period.

3 IMPACT OF INADEQUATE NUTRITION ON PRODUCTIVITY

2.1 The use of UMMB for supplementing crop residues based diet for livestock has been well documented in ruminants and has the potential to increase the viability of livestock production and increase household income. UMMBs can be fed throughout the year but are more beneficially utilized during the dry season or when the animals are grazing on low quality fodder.

2.2 In the dry season the available pastures and crop residues are usually in short supply and are often poor and are characterized by low energy, protein and minerals which are required to maximize rumen microbial activity.

2.3 Feeds available in the dry season also have a high content of dietary fibre, associated with high lignin and silica, which has a limiting effect on intake and digestibility. Inadequate nutrition in the dry season results in:

2.3.1 Reduced body weight and condition scores.

2.3.2 Poor milk yields.

2.3.3 Retarded growth and increased mortality rates.

2.3.4 Increased vulnerability of animals to stress and disease challenges, which result in animals performing below their expected genetic potential.

To improve the productive capacity of smallholder owned ruminant animals, there is a need to develop a feeding strategy that has the potential to be used as dry season supplement**. Urea-Molasses Mineral Blocks (UMMB)** is a cheap and effective dry season feed supplement formulated to meet the range of circumstances**.**

3 WHAT ARE UREA-MOLASSES MINERAL BLOCKS (UMMB)?

3.1 These are lick blocks containing urea, molasses, minerals and other multi-nutrients. The feeding of the blocks is a convenient and inexpensive method of providing a range of nutrients required by both the rumen microbes and the animal, which may be deficient in the diet. The main justification for using the blocks is on the basis that the block licks are regular source of nutrients to rumen microbes, which themselves serve as source of nutrients to host animal and help in better digestibility of fibrous feeds. Besides, convenience for packaging, storage, transport and ease of feeding, there are some other important considerations as well.

3.2 The ingredients are designed to provide a wide range of nutrients to cover all potential deficiencies. Minerals are often deficient in cut and carry grass or crop residue based feeding systems. Grasses from road sides or wastelands are particularly low in minerals as generally no fertilizer is used and the grasses have often been cut for decades for ruminant production, thus depleting the minerals reserves of both soils and the plants.

4. WHY MOLASSES AND UREA IN THE FORM OF UMMB LICKS?

4.1 Molasses is a well-known source of energy and a widely available concentrated form of fermentable carbohydrates that has no role in human nutrition. Urea is a product, which after hydrolysis into ammonia in the rumen can be used as a nitrogen source by the microbes.

4.2 Therefore, a supplement containing these two can stimulate the growth of microbes in the rumen, permitting a better digestion of the forages and a greater production of microbial protein, which could provide essential nutrients in the intestine.

4.3 Supplementation systems based on liquid molasses are difficult to use under extensive nomadic livestock systems or by the smallholder farmers. The main reasons are the necessity to have a minimum of infrastructure to transport and distribute the liquid mixture (tanks for transport and storage, feed troughs etc.) and the difficulty to manipulate this by-product, which is a very viscous and sticky liquid. Moreover, it is difficult to regulate the intake of molasses and urea in the liquid form which sometimes causes toxicity to animals due to its over-ingestion.

4.4 The main justification for using blocks to provide deficient nutrients is, therefore, to regulate urea and molasses intake, their convenience for packaging, storage, transport and ease of feeding.

5. WHAT ARE THE BASIC FEED INGREDIENTS OF THE BLOCKS AND WHAT NUTRIENTS DO THEY PROVIDE?

5.1 The ingredients used are:

5.1.1 Molasses
5.1.2 Urea
5.1.3 Cereal brans
5.1.4 Oilseed meals
5.1.5 Lime/Calcium oxide
5.1.6 Common salt
5.1.7 Minerals.

6. SIGNIFICANCE OF DIFFERENT INGREDIENTS IN UMMB LICKS

6.1 The molasses provides a range of minerals (except phosphorus) and a complete mixture of vitamins. Because of both its taste and smell molasses makes blocks appetizing for animals.

6.2 Urea provides the small amount of extra nitrogen required for utilization of the dry matter in addition to that present in normal dry season forage. It is sufficient to maintain the ammonia level in the rumen, at a constant and a sufficient amount for better development of the micro-organisms, leading to better digestion of fibrous feeds.

6.3 Cereal brans are high in phosphorus, trace minerals and also a range of vitamins.

6.4 Oilseed meals provide both soluble and insoluble proteins and are a good source of phosphorous.

6.5 Mineral requirements for animals in maintenance conditions or survival conditions are low. Generally speaking, mineral deficiencies appear only when production is high. If a nutritive deficiency is proven, which leads to economic loss, it is possible to include minerals in the mixture to cure this deficiency. Minerals and salt provide much of the macro and micro mineral requirements of the microbes as well as those of the host animal.

6.6 The UMMB licks, therefore, provides the nutrient requirements of both the microbes and the host animal.

7. WHAT ARE THE ADVANTAGES OF UMMB LICKS?

7.1 Increases feed intake (i.e. intake of more nutrients).
7.2 Nutrients utilization/digestibility increases by 10-15% particularly of crop residues.
7.3 Its continuous use ensures early conception, minimum repeat breeding and decreases inter-calving intervals.
7.4 Improves milk and fat production.
7.5 Due to complete profile of nutrients, its intake overcomes minimum deficiency problems.
7.6 Especially effective in malnourished animals and also where concentrates are not fed regularly to the animal.
7.7 All the necessary amino acids are generated by the rumen microflora with the help of UMMB feeding.
7.8 Due to long shelf life and easy transportation it serves best feed/ration during emergencies like famine, floods, droughts, crop failure, etc.

8. IMPORTANT PRECAUTIONS FOR UMMB FEEDING

8.1 Dispense UMMBto facilitate only licking by the animal. Use specially designed dispensers to avoid over ingestion.
8.2 The UMMB should be readily available to animals to ensure licking as per their requirements i.e. should have easy access to the UMMB.
8.3 Do not dissolve the UMMBin water for feeding the animals.
8.4 The UMMB should be protected from dung, litter, urine, fodders and rain water.
8.5 Do not feed the UMMBto animals that are sick.
8.6 Do not feed to calves below 3 months of age.

9. PRESENTATION AND DOSING

9.1 The block weighs 3 kg and is most appropriate for feeding dairy cattle under smallholder situations.
9.2 Each block will last for 7 days. Therefore, blocks can be replaced once a week on a specific day, making it a regular activity for the milk producers/ dairy farmers.
9.3 Average consumption of UMMB in different animals is shown below:
   9.3.1 For adult cattle from 400 to 800 g/day.
   9.3.2 For small ruminants, sheep and goats, from 100 to 250 g/day.
   9.3.3 For camels, from 300 to 500 g/day.

10. METHOD OF FEEDING AND FEEDING GUIDELINES

10.1 Distribution of the UMMBsshould be regular and continuous so as to avoid another adaptation period for the ruminal microflora, which in fact may take another two weeks; each time distribution of the UMMBsis recommenced after a long gap.

10.2 The method of presenting the UMMB depends upon the feeding system:

10.2.1.1 If the animals graze on pasture during the day, the UMMBmay be given in the evening when they return.

10.2.1.2 In stall fed animals UMMBcan be made available throughout the day, in a specially designed dispenser.

10.2.1.3 When the stock of UMMBis limited, it is advisable to distribute them in the order of priority:

10.2.1.3.1 Offer UMMB to animals which are very weak and cannot follow the herd.

Finally, one should recall that the UMMBcontains urea, which can be toxic to non-ruminant animals. It is therefore advisable to respect the following precautions.

10.2.1.3.2 Only give the UMMB to ruminants (cattle, sheep, goats, buffaloes). Only ruminants are able to take advantage of urea in the blocks, owing to the action of the microbes in their rumen. The blocks should therefore never be given to non-ruminants like equines, pigs or rabbits.

10.2.1.4 The UMMBshould be used as a supplement and not as the basic ration.UMMB licks are "catalytic" supplements, which facilitates ruminant animals to ensure better utilization of poor quality forages; but not to replace them. A minimum of coarse forage in the rumen is essential. In consequence, one should never give the UMMB to an emaciated animal with an empty belly as one risks causing poisoning due to an excessive consumption of urea.

10.3 It is advisable to respect a transition period and only to present the UMMBprogressively over a period of one or two weeks so that the microbes in the rumen become adapted to this new supplement which contains urea. The UMMB,therefore, should not be given to the animals for more than few hours each day (2 to 4 hours).

10.4 In case they are refused, it is advisable to sprinkle some bran or other appetizing product on top of the UMMB to help the animal become accustomed to it. Once the animals are adapted to the supplement, they will regulate their intake on their own and the UMMB can be made available all the time.

11. PRODUCTION PROCESS OF UMMB

11.1 Grindable materials, such as urea, phosphate supplement and de-oiled rice bran (DORB) are ground separately to reduce the particle size to the desired mash size according to the sieve fitted in hammer mill. Ingredients, in accordance with the formulation, are mixed in the pan mixer in a particular sequence.

11.2 In the beginning, about one kg of DORB is put in the mixer and run for 1-2 minutes, to avoid leakage of molasses through the narrow gaps. Now, weighed quantity of molasses is taken in the mixer, to which weighed quantity of urea, DORB, rice polish and mineral mixture are added. After 5-10 minutes of mixing, calcium and magnesium oxides are added, followed by 2-3 minutes mixing.

11.3 At the end, entire quantity of phosphate supplement is added in mixer and the whole mass is discharged in SS tray, within 2-3 minutes. Delay would lead to hardening of material inside the mixer and its discharge would be difficult later on.

11.4 Material is weighed into three kg balls, before subjecting them to pressing device, where material is converted in to rectangular semi solid blocks. These blocks are put in the HMHD bags and can be heat sealed in next day.

11.5 Standard formulation for UMMB (a batch of 200 kg)

Sl. No.	Ingredients	Formulation (%)
1.	Molasses	45
2.	Urea	2-6
3.	Mineral mixture	4-6
4.	De-oiled rice bran	12-14
5.	Rice polish fine	13-16
6.	Magnesium oxide (Commercial grade)	2
7.	Calcium oxide (Commercial grade)	4
8.	Phosphate supplement (to adjust the pH) Di-ammonium phosphate fertilizer grade	8-10
Total		**100**

12. ESTIMATED COST OF UMMB PLANT

CAPACITY - 3 TPD (3 kg each, 300- 330 blocks per shift)

Urea molasses mineral block size: 24cm x 15 cm x 6.5 cm height

12.1 **Pan mixer:** consists of SS drum (1500 mm dia. x 450 mm height) with mixing unit, mild steel mobile structure, 10HP motor, gear box, stainless steel tray with mild steel trolley, control panel with digital A-meter, capacity 200kg/batch

12.2 **Automatic pneumatic pressing device:** consists of stainless steel rotary table, pneumatic control panel, pneumatic cylinders, control panel, nylon belt conveyor with 0.5 HP motor & gear box

12.3 **Air Compressor:** (1) Tank mounted package (2) Air receiver capacity –250 litre (3) Working pressure –12kgf /sq. cm. (4) Displacement 0.500 cu. mtr./min. (5) Free air delivery 0.390 cu. mtr./min. (6) Cylinder –2 nos. (7) Cylinder size & stroke – 100x60x85 mm. (8) Type of cooling – air (9) Compression stages - 2 nos. (10) Type of starter – DOL (11) Motor – 5HP, 1440 rpm, 3 phase.

12.4 **Hammer mill:** with cyclone system (Model no. MM 0), 10 HP motor, control panel with digital A-meter, capacity- 100-150 kg/ hr., including spares like screens (1.5mm, 2mm, 3mm, 5mm), liner, hammer set & belts

12.5 **Electrical Distribution board (including wiring):**

(DB –100 Ampere MAIN MCB)

12.5.1 Pan mixer motor- 10 HP, 3 Phase with neutral and earth.
12.5.2 Automatic pressing device - 1 HP, 3 Phase with neutral and earth.
12.5.3 Hammer mill - 10 HP, 3 Phase with neutral and earth.
12.5.4 Air compressor - 5 HP, 3 Phase with neutral and earth.
12.5.5 Molasses feeding pump - 3 HP, 3 Phase with neutral and earth.
12.5.6 Spare feeder - 5 HP, 3 Phase (2 nos.) with neutral and earth.
12.5.7 Heat sealer- 15 ampere single phase point with neutral and earth.

12.6 Tentative cost of UMMB plant:including installation & commissioning (excluding transportation, insurance, procurement charge and taxes): **Approx. NPR 40,00,000/-**

13. ADDITIONAL FACILITIES TO BE REQUIRED FOR SETTING UP THE UMMB PLANT

13.1 Incoming cable for 40 HP (max.) to distribution board and internal cabling from distribution board to individual equipment of urea molasses block plant (pan mixer, automatic pressing device, air compressor, hammer mill, molasses feeding pump, heat sealing machine).

13.2 Concrete flooring for working area.

13.3 100/200kg & 10kg weighing balance for weighing raw materials and 3 kg UMMB (finished product).

13.4 Hand operated heat sealing machine.

13.5 Space requirement for installation of the plant: A well ventilated industrial building of floor area of 20 mtr. (L) x 8 mtr. (W). The building should have a height of about 5 mtr. (H) with entrance gate of 2.5 mtr. wide and 2.5 mtr. high. Suitable earth pit to connect all earth points**.**

13.6 Packing material for urea molasses block:High molecular weight high density (HMHD) bags (14"x 9") of 250-300 gauge for primary packing and woven sacks (HDPE) for secondary packing.

13.7 Storage facilities for storing various raw materials & finished goods (MS rack),MS storage tank of capacity-10MT- 2 nos. for storing molasses outside the plant building (as per drawing) Molasses pump of 15,000 litres per hour capacity loading molasses to MS tank.

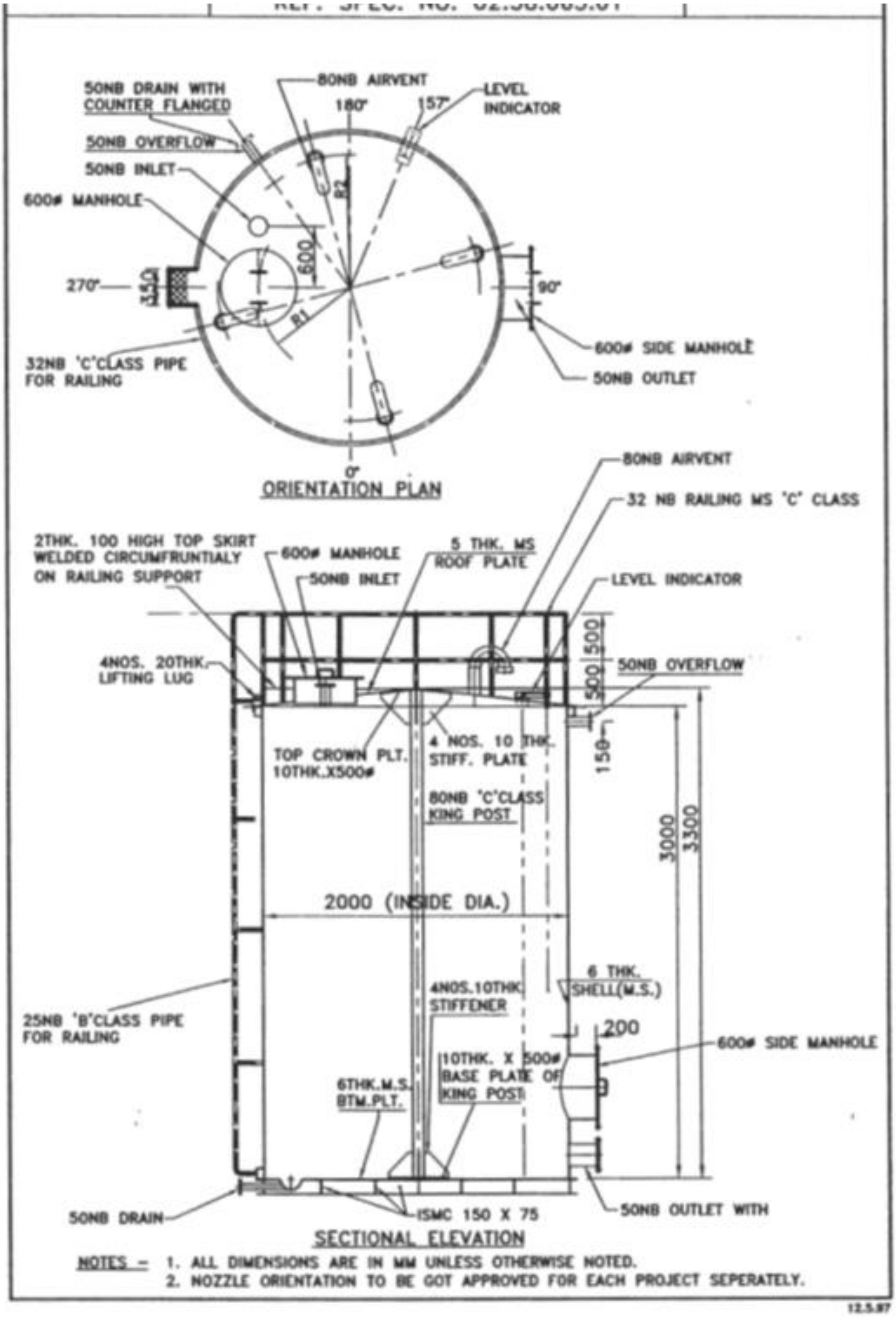
13.8 Molasses service tank of capacity-1000kg 1no. with platform, ladder & molasses measuring SS tank of cap. 100kg with ball valve near to pan mixer (as per the drawing).

13.9 Molasses pump of capacity 1000 litres per hour for molasses service tank and molasses piping

13.10 Road permit to supplier for transporting equipment at site, if applicable.

13.11 Urea molasses block plant is skid mounted and could be installed at a convenient place in the godown identified for this purpose.

14. LAY OUT PLAN OF UREA MOLASSES MINERAL BLOCK PLANT



15. PROTECTIVE CLOTHING AND SAFETY ASPECTS

15.1.1.1 Wear a laboratory coat and gloves when handling powdered materials.

15.1.2 Face shield or goggles to protect the face and eyes from splashes should be worn when mixing or handling fine powder.

15.1.3 Apply a good quality barrier cream on hands and forearms to prevent dermatitis and general skin irritation, after handing of urea/phosphate supplements.

4. ENVIRONMENTAL ASPECTS RELATED TO UMMB PLANT AND UMMBs DISTRIBUTION A SOURCE OF INCOME TO RURAL WOMEN

4.1.1 There is no effluents from UMMB plant, so setting up UMMB plants have no adverse effects on the environment.

4.1.2 Use of UMMB licks on wider scale helps in reducing methane emission, as feed utilization efficiency is increased, esp for crop residues based diet in developing countries like Nepal.

4.1.3 Commission from distribution of UMMBs through rural women could help in providing them livelihood in different parts of project districts.

4.1.4 It will be specifically very useful for animals producing 2-5 litres milk per day, especially during lean periods when no green fodder is available.

Chapter 4
Enrichment and Densification of Crop Residues

1. INTRODUCTION

1.1. Nutritive value of crop residues is low and these form the bulk of basal diet of ruminants in Nepal.

1.2. There is severe shortage of dry fodder in the hilly areas and mountains, whereas, dry fodder is wasted in the surplus areas, especially in Terai region.

1.3. It is proposed that two straw enrichment and densification plants will be set up for enrichment and densification of crop residues, especially paddy straw.

1.4. Densified straw will be transported from surplus to deficit areas. This will reduce transportation cost, save storage space and help is judicious utilization of crop residues.

1.5. Livestock production accounts for 40% of the gross value of the agricultural production globally and this figure is likely to go up, as the demand for livestock products is increasing rapidly with the increase in incomes and urbanization.

1.6. Besides their potential to raise incomes and improve nutrition on the farm, livestock have important integrative function in the farming system.

1.7. The tropical regions of the world vastly differ in climate, natural resources and socio-economic-cultural aspects. These regions have largely remained traditional in their approach to livestock production activities due to their social, economical, geographical and ecological compulsions.

1.8. Livestock plays a central role in the natural resource based livelihood for the vast majority of the population living in the tropics, which predominantly is confined to rural areas.

1.9. In the rain fed hotter regions of the tropics, livestock are the main sustenance factor for rural economy, contributing to the livelihood of resource poor subsistence farmers in a number of ways: income from products, insurance against drought, emergency cash requirements, household nutrition, fuel for cooking, manure for crops and draught power for farming.

1.10. Apart from the hostile hot and hot-humid climate, the region has a large human and livestock population, exerting pressure on land, which, coupled with degraded unmanaged pasture lands results in shortage of feeds and fodders.

1.11. In addition, available feed resources are not efficiently utilized due to lack of information on feeding of balanced rations by small holder farmers.

2. HOW TO CONSERVE SURPLUS CROP RESIDUES

2.1 Weaker section of community mainly the small and medium milk producers/farmers fail to harvest and collect left out crop residues due to non-availability of appropriate mowers and pick up devices at grass root levels/villages.

2.2 Such wastage of crop residues after harvesting of crops in surplus region having acute shortage of feed resources like roughage, protein & energy to the extent of 50%.

2.3 It is high time that we should create appropriate infrastructure for straw management at village level and towns at strategic locations to conserve in the form of densified fodder blocks and create buffer stock of valuable crop residues for small, poor, marginal and under privileged dairy farmers of Nepal.

2.4 Straw management infrastructure comprises of appropriate mowers, bunkers, balers, choppers, crushers, loaders, conveyors, and enrichment cum fortification devices.

2.5 This sector has been grossly neglected by our village resource planners and dairy professionals with the assumption that the dry fodder or straw is free when you cultivate grains, pulses, oilseeds etc. But, now the situation has changed; free fodder or free straw is not available at village level.

2.6 Many a times the crop residues are traded almost at the same price as concentrate feed ingredients, especially during scarcity periods.

2.7 The farmers move these crop residues in traditional way from surplus to deficit areas.

2.8 Since bulk density of straws is very low, their transportation cost is high and storage space requirement is also more, if these are handled in loose form.

2.9 If crop residues are supplemented with low cost deficient nutrients and then densified, it is possible to save the transportation cost and storage space and at the same time nutritive value of straws can be improved for better growth and milk production.

2.10 Different straws can be enriched and densified, depending up on their chemical composition and physical characteristics.

2.11 After enrichment and densification, straws can be transported from surplus to deficit areas.

2.12 Feeding of enriched and densified fodder blocks, wastage of straws can be minimized drastically.

2.13 Through straw based feed blocks, it is possible to meet the macro and micro nutrient requirement of animals. Animals, thus, get balanced ration and there is improvement in milk production about 0.50 litre per day per animal, on feeding straw based blocks.

2.14 Fodder blocks would be useful during natural calamities such as drought, flood, cyclone etc., when even piece of fodder is not available.

2.15 Carry over effect of such natural calamities on milk production could be reduced.

2.16 By setting up of fodder densification plants in fodder surplus areas, it would be possible to supply enriched and densified fodder blocks at economical rate in fodder deficit areas.

3. PROJECT OBJECTIVES

3.1 To demonstrate benefits of feeding enriched straw to over 1000 animals.

3.2 Increased palatability of fodder.

3.3 Reduced fodder wastage

3.4 Savings on storage and transport cost

3.5 To demonstrate the usefulness of biomass Bunkers at strategic locations

3.6 Better health and increased productivity of animals

3.7 To promote wet biomass conservation technologies at farmer level so that their dry fodder could be moved out of village for trade after enrichment

3.8 Educate farmers and village resource planners on benefits of TMR feed in phase two of the project

4. CORE ISSUES RELATED STRAW MANAGEMENT

4.1 It is well established that straw based fodder / crop residues have following limitations:

4.1.1 Poor source of nitrogen & energy.

4.1.2 Poor source of minerals.

4.1.3 High silica & crude fibre.

4.1.4 Most of the crop residues are highly lignified, hence poor digestibility and palatability

4.1.5 Straw management machines are crop specific.

4.2 In spite chronic limitations the crop residue remains basal ration for animal rearing in developing countries.

4.3 In future also this trend will continue, because developing country cannot afford to spare dedicated land for green fodder production.

4.4 Due to high cost of farm inputs and better returns on cash crops fodder area of the country is bound to decrease in future.

4.5 Contribution of crop residues in daily ration of dairy animals is as high as 60 to 70%. Each adult animal needs about 5 to 8 kg of dry straw depending on its body weight.

4.6 Due to low levels of protein, energy, minerals and other limitations in straw based diets, animals are facing following problems for the last many decades:

4.6.1 Low milk yield

4.6.2 Reduced productive life

4.6.3 Reduced breeding efficiency

4.6.4 Longer inter calving period

4.6.5 Shorter lactation length

4.6.6 Poor birth weights

4.6.7 Higher age at first calving.

4.7 Proper supplementation, enrichment, treatment and densification of bio-waste at strategic locations can solve many problems associated with crop residue management and animal productivity.

5. ADVANTAGES OF ENRICHMENT AND DENSIFIED CROP RESIDUES

5.1 It is more palatable than raw crop residues.

5.2 It is fortified with protein, energy and minerals.

5.3 Storage and transportation costs of biomass are reduced.

5.4 Reduction in wastage of dry fodder due to proper conditioning and chopping – could be as high as 40 % specially in tough residues having hard internodes.

5.5 Least fire hazard.

5.6 Buffer stock useful for market intervention.

5.7 Buffer stock can save high value genetic material during calamities.

5.8 Reduced Global warming.

Many kinds of densification machines are available now for enrichment and densification of straws. The densified feed block offers a variety of benefits, both to the farmer and the feed manufacturers. This could be a promising technology for the regions of green fodder shortage.

5.9 *A promising way to feed a balanced ration to ruminants.* In Nepal and other tropical countries, normally it is very difficult for illiterate or semi-literate farmers to compute a balanced feed for the animal. In fact, except at some organized farms, practice of feeding balanced rations is almost non-existent in many developing countries. Densified feed block is a complete balanced feed. By feeding an animal a balanced feed through feed block, one can expect an improved nutrient utilization, resulting in optimum productive and reproductive performance from the animal.

5.10 *An efficient nutrients delivery system – less feed wastage.* While feeding densified block, the animal is not given any opportunity to select and consume more digestible feed components. This reduces the feed wastage and thus, is an efficient delivery system of supplying feed nutrients to the animal, which in itself is economically advantageous to the farmer.

5.11 *Time as well as labour saving– respite to women in hills.*Feeding of densified blocks to animals is simple and a hassle-free exercise. By feeding densified block, the labour expenditure is reduced by 30–40%. Being a readymade feed, the farmers find it easier to feed them. According to a farmer "it takes him just 5 – 10 minutes to feed 20 animals, as against two hours for feeding the same number of animals in a conventional manner". This could also be a clear advantage to the women in hills, who generally look after the feeding and management of dairy animals, spending best part of their lives in drudgery, by cutting, collecting and transporting huge loads of forest grasses on daily basis.

5.11 *Feed as blocks require lesser storage space.* The process of densification increases the bulk density of the straw based feed by three times, and at the same time it reduces its volume by the same proportion. Accordingly, lesser storage space is required to store the bulky feed, especially straw. The farmer could use the extra space for other farm activities.

5.12 *Densified feed cheaper and easier to transport.* Carrying straw in bulging trucks is hazardous and causes large number of accidents on the roads. Since the feed blocks occupy approximately one-third lesser space and volume than the original components in the uncompressed state, more feed (by weight) can be accommodated and transported within the same space. This makes the transportation of feed block much easier and cheaper.

5.13 *Better way to manage crop residues and reduce pollution.* In many regions in Nepal as well as in other parts of Asia, straw worth millions of dollars is also burnt in the field after harvesting of the grains. If the residual straw left in the field is mechanically collected and converted into feed blocks, not only this valuable feed resource could be effectively used, but the emission of greenhouse gases, caused by burning of straw could also be avoided. In addition, the high temperature generated during the burning of straw kills the soil microorganisms, affecting adversely the soil fertility. Also there is less dust pollution when the feed is transported as blocks rather than as loose straw.

5.14 *Lesser methane emission from animals.* The inclusion of concentrate to straw diets reduces methane emission from rumen. The emission of methane gas (a greenhouse gas) from ruminants can be reduced by 10 to 15 %, when straw is mixed with concentrate ingredients and minerals to make it a balanced feed. In straw based densified feed block, the addition of concentrate and minerals in desired proportions makes it a balanced feed, causing reduction in methane emission from animals.

5.15 *Improved productive performance.* Feeding of densified complete feed block has a positive effect on production of the animals. While the growth rate of calves could increase by 25–35%, the milk yield could increase by 15–20%. There could be some increase of fat content in milk. After feeding densified block, the milk yield of the animal persists at high level over a longer period, resulting in increase in total lactation yield. This may be explained by the fact that the feeding of straw based complete feed blocks eliminates any day to day dietary fluctuations to the animal. It provides the rumen microbes a constant supply of the same type of feed/substrates, bringing stability in the rumen environment and making ruminant system overall more efficient.

5.16 *Improved reproductive efficiency.* Because ofthefastergrowth rate, feeding of densified straw blocks could result in early maturity and early age at first calving for the animals. The age of heifers at first calving may decrease by about 4– 6 months, which is a distinct advantage in lowering the cost of rearing animals. The farmers report that the feeding of straw blocks reduces calving interval and animals generally conceive within 3 months after calving. As a result of these, overall reproductive efficiency of the animal also increases. Apart from optimum supply of energy and proteins through complete feed block, the animals get proper quantities of minerals and vitamins as per their requirement, which enhances reproductive efficiency. The occurrence of reproductive problems such as late maturity, anoestrous and repeat breeding condition can be decreased in animals fed straw based feed blocks.

5.17 *Better health status.* The optimum supply of nutrients and micro-nutrients also has a positive effect on the maintenance of good animal health The straw based feed block feeding keeps the animals comparatively free from common metabolic and reproductive disorders and provides immuno-protection against infectious diseases. Consequently, this may also reduce the farmer's expenditure on maintaining proper health of the animals.

5.18 *Feed banks can be set up as a pre-emptive disaster management measure.* With the advent of feed block technology, it is possible to set up feed banks nearer to feed deficit areas. Because of easy handling, transportation and storage of the straw based feed blocks, the technology could improve preparedness against natural calamities, and save animals from hunger and death during these emergency situations. The blocks can even be air lifted to the remotest places to avert disasters.

5.19 *Scope for value addition – block as a vehicle for medicine or neutra-ceuticals administration.* There is substantial room for improving the quality of straw based complete feed blocks. Its value addition could be a continuous exercise through extended research, trying different supplements, newer feed additives, neutraceuticals, anthelminths and herbal extracts to improve their over-all nutritional quality.

5.20 *Better economic returns through providing stability in feed and milk prices.* The benefit provided by easier storage of feed blocks makes possible to supply uniform quality of the feed throughout the year, with lesser price fluctuation, as against the large price fluctuation and irregular supply of straw and other feed ingredients in different seasons. This could also have an impact on stabilizing milk prices, irrespective of seasons. Better performance of the animals obtained on feeding the densified straw blocks also brings better returns to the farmer.

6. PROPOSED IMPLEMENTATION DESIGN

6.1 For reducing wastage of feed and fodder, proposed enrichment and densification plant of the capacity range 1 MT/hour suitable for local biomass conditions is to be established.

6.2 The plant will comprise of modern machines like field choppers, crushers, shredders, grinders, mixers, densification press as per need of biomass.

6.3 The major raw materials i.e. straws would be procured from local farmers or contractors using standard purchase norms.

6.4 Fortification/ enrichment ingredients would be purchased from contractors or industries like sugar factories, solvent plants, oil mills and food processing industries etc., as per the need or imported from the neighbouring countries.

6.5 After processing of raw material in the straw densification plant, the feed in appropriate form would be sold to farmers in bulk or small packs through the network of dairy cooperatives/NGOs or alternative means.

6.6 Cost effective harvesting, chopping, sun drying and pick up for various kinds of crops and crop residues, would be introduced in operational area of the plant.

6.7 This would help the farmers to understand the importance of the suitable farm machinery to reduce the wastage in mowing and picking up the fodder automatically with or without wilting in field conditions.

6.8 Choice of following add on features on many mowers would help in increasing the quantum and the efficiency of straw recovery, cartage and storage.

6.8.1 Faster sun drying attachments like stem cracking, conditioning

6.8.2 Wind rowing-swathing

6.8.3 Auto infield bale making

6.8.4 Auto infield bundle making and dust free threshing

6.8.5 In field chopping, crushing, loading; single or multi-steps.

6.8.6 Biomass Storage Silos

6.9 The project will demonstrate biomass storage to promote storage of crop residues in peak season and make use of it in lean/ deficit season.

6.10 Apart from fodder conservation technique, it ensures buffer for the lean periods.

7. COST ESTIMATE OF STRAW DENSIFICATION PLANT:CAP 20 MTPD

Sl. No	Equipment required	Capacity (Acres/h)	Capacity (ton/h)	Quantity	Unit	Estimated cost
A	**PLANT & MACHINERY SECTION**					**NPR Lakh**
1	Grass Mower & conditioner with prime mover	1		1	set	22
2	Hay raker liner & pick up set	1		1	set	29
3	Choppers	1		2	set	16
4	Crusher, conditioner mill 360-degree screen		1	1	set	16
5	Grinder & pre mixer set with accessories		1	1	set	32
6	Material handling equipment - conveyors & accessories as per need		1	1	set	16
7	TMR - PMR mixer with prime mover & accessories as per need		1	1	set	48
8	Packing equipment with sealing, conveying accessories		2	1	set	13
9	Molasses storage, dosing & handling system			1	set	16
10	Utility services as per need			1	set	5
11	Tools, Tackles, gadgets, weighers as per need			1	set	5
12	Office equipment, furniture, testing equipment, misc. items etc. as needed			1	set	6
13	Power connection, transformer, DG set, statutory deposits, line charges etc			1	set	32
14	Panels, DB's, Cables, switch gears, street lights, protection devices etc			1	set	16
15	Pelletiser for the above TMR (high levels of grass)		1	1	set	40
16	Block making machine (as an alternative to pelletiser)		1	1	set	32
17	Contingencies			1	set	5
18	Consultants & designer's fee			1	set	3
	Sub-Total for Plant & Machinery (A)					**350**
B	**CIVIL WORKS**					
19	Office and related misc buildings			20	Sq m	6
20	Plant machinery & godown area low cost			400	Sq m	95
21	Boundary / fencing works - nominal assumed			1	set	5
22	Land development & road works - nominal assumed			1	set	5
23	Procurement and sun drying yard			200	Sq m	10
24	Foundation and trench works			1	set	6
25	Site surveys work & field visits			1	set	2
26	Biomass storage bunkers - model at strategic locations			200	Sq m	38
27	Contingencies			1	set	3
28	Consultants & designer's fee			1	set	5
	Sus-Total for Civil Works (B)					175
Grand Total (A+ B)						**525**

8. ENVIRONMENTAL, ECONOMICAL AND SOCIAL BENEFITS OF STRAW ENRICHMENT AND DENSIFICATION OF CROP RESIDUES

8.1 Feeding of enriched straw will have positive impact on the environment and improve in quantity and quality of milk being produced.

8.2 It will enhance livestock productivity through better feeding practices as per stage of lactation of animals.

8.3 It will improve the income of the farmers through improved livestock

productivity by better feeding of cattle in the region.

8.4 Also, it will reduce the wastage of fodder substantially.

8.5 The sub project would support the development of milk producers with a view to increase the organisational capacity of milk producers and eventually, their more effective participation in cooperative institutions.

8.6 Pollution caused due to crop residue burning would be reduced.

Chapter 5
Proposed Draft Feed Act for Nepal

Government of Nepal

Ministry of Agriculture and Livestock, Nepal

Notification

Dated ……………………………

In exercise of the powers conferred by The Governor of Nepal is pleased to make the following rules for the implementation of the provisions contained in "The Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture, Rules, 2019".

Rules

General

1 Title and Commencement:

1.1 These rules may be called the "The Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture, Rules-2019.

1.2 These shall come into force on the date of notification of these Rules.

2. Definitions:

In these Rules, unless the context otherwise requires:

2.1 *'Bill'* means The Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture, Bill, 2019 as amended from time to time.

2.2 *'Referral laboratory'* means an analytical laboratory recognized by the Registration Authority for the re-analysis of a sample, identification of which shall not be disclosed to the manufacturer/ dealer.

2.3 *'Re-analysis of sample'* means analysis of the part of the sample retained by the leader of the sampling team.

3. Registration Authority:

3.1 Ministry of Agriculture and Livestock, Nepal will be the Registration Authority under the "The Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture, Rules-2019"

3.2 Ministry of Agriculture and Livestock, Nepal can delegate his powers as Registering Authority to the District level officers of the department.

4. Registration for Manufacture/ Dealer:

4.1 any person desirous of carrying on business of manufacture, storage, sale and/or distribution in any manner of Compounded Cattle Feed, Calf Starter, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures and other variants thereof shall obtain a Registration Certificate to be a Manufacturer from the Registration Authority under the provisions of "The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixtures, Rules 2019"

4.2 any person desirous of carrying on business of storage, sale and/or distribution in any manner of Compounded Cattle Feed, Calf Starter, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures and other variants thereof shall obtain a Registration Certificate to be a Dealer from the Registration Authority under the provisions of "The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixtures, Rules 2019"

4.3 a person; who at the time of commencement of this Bill, was carrying on business of manufacture, storage, sale or distribution of Compounded Cattle Feed, Calf Starter, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures and variants thereof, shall obtain a Registration either as a Manufacturer or Dealer (as the case may be) within a period of 90 days from the date of commencement of these Rules.

4.4 a separate Registration shall be necessary for each place of business and for 'Manufacturer' and 'Dealer' separately.

4.5 a person desiring to get himself registered or desiring to renew his Registration under these rules shall make an application to the Registration Authority in the following Forms alongwith documents listed in the checklist, which include registration with the Industry Department and No Objection Certificate from Pollution Control Board. Trade Mark Registration Certificate from competent authority.

i. Form-I *for Registration of Manufacturer*
ii. Form-II *for Registration of Dealer*
iii. Form-III *for Renewal of Registration of Manufacturer*
iv. Form-IV *for Renewal of Registration of Dealer*

4.6 The fee for registration, renewal and supply of a copy of Registration Certificate shall be as under:

i. Registration of a manufacturer NPR. 10,000/-
ii. Renewal of Registration of a manufacture NPR. 5000/-
iii. Registration of a dealer NPR 3000/-
iv. Renewal of Registration of a dealer NPR 2000/-
v. Duplicate copy of Registration NPR 500/-.

The fee will have to be deposited through one of the following modes:

i. by way of Demand Draft drawn in favour of "………..to be decided………" payable at……...
ii. On line.
iii. Through RTGS

The demand draft should be attached with the application in original.

4.7 The Registration Authority on receipt of application shall get the inspection of the unit done through his authorized representative(s).

4.8 The Registration Authority shall get the application processed for Registration/ Renewal of Registration (as the case may be) to complete the process within time enabling him to either issue the Registration Certificate or rejection letter within the stipulated time of 60 days.

4.9 The Registration Authority shall issue the Registration/Renewal of Registration in the prescribed Form-I, Form II & Form-III respectively. A certificate to this effect shall be issued in Form-IV in addition to the registration letters in Form-II and Form-III. The registered manufacturer/ dealer shall be required to hang the certificate issued in Form-IV on the wall of his premises at a prominent place.

4.10 The Registration made shall be valid for a period of three years at a time commencing from the day of Registration.

4.11 If the Registration Authority is satisfied that the applicant does not fulfill the conditions for the grant of registration, shall reject the application for registration. Before, doing so he shall afford an opportunity to the applicant of being heard.

4.12 Any person aggrieved by an order of the Registration Authority refusing to grant or renew a registration, may appeal to the Secretary, Ministry of Agriculture and Livestock, Nepal within thirty days from the date of receipt of such order by him.

4.13 No order shall be made under this clause unless an aggrieved person has been given a reasonable opportunity of being heard.

4.14 Pending the disposal of an appeal, the Secretary may direct that the order refusing to grant or renew a registration shall not take effect until the appeal is disposed of.

5. Quality Specifications:

5.1 Cattle Feed, Calf Starter/Calf Growth Meal, Proprietary Feed & Straw Based Feed and Mineral Mixtures and concentrates shall be the same as are prescribed in Annexure A, B, C, D & E respectively for concentrates specification shall be as per Annexure F.

5.2 "Expert committee" shall be constituted with the approval of Secretary, Ministry of Agriculture and Livestock, Nepal to review all technical matters including specification.

5.3 However, Registration Authority can also approve quality specifications for proprietary feeds and mineral mixtures, other than mentioned in Annexure A to F in consultation with the "Expert Committee".

6. Packing, marking and labeling:

6.1 Every holder of a registration certificate shall comply with the following requirements:

6.1.1 Every type of Cattle feed/Meal shall be packed in clean and sound plain jute or HDPE or cloth or paper bags, in 50 kg net quantities. The mouth of each bag shall be machine-stitched. On every bag of the cattle feed, calf starter and calf growth meal, proprietary feed, straw based feed, mineral mixture a declaration shall be made produce as per "The Nepal Regulation of Compounded Cattle Feed, Concentrate and Mineral Mixture Rules 2019."

6.1.2 Type A, B, C and D types of feed shall be packed in bags as mentioned under 6.1.1 in green, blue, yellow and black letters respectively, all bags in white colour base.

6.1.3 Mineral mixture shall be packed in moisture-proof sound and clean bags, free from causal agents of infectious diseases and parasites in 1 kg, 2 kg, 5 kg, 10 kg and/or 50 kg quantities;

6.1.4 Concentrates shall be packed in clean and sound plain jute or HDPE bags, in 50 Kg. quantities.

6.1.5 Every bag in which cattle feed, concentrates or mineral mixture is packed bear the registration number, name and business address and trade name of the manufacturer, trade mark approved by the office of the Registrar of the Trade Mark, net weight in kg at the time of packing and the maximum retail price;

6.1.6 Every bag in which cattle feed or mineral mixture is packed shall indicate the type/category;

6.2 Each bag in which cattle feed is packed shall contain a printed leaflet, format of which shall be approved by the Registration Authority, indicating batch number, date of manufacture, address of manufacturer, registration number, the nutrient composition of the feed, ingredients used in manufacturing cattle feed, actual level of mineral mixture, vitamins, feed supplements added with their proportions and such other particulars as may be stipulated by the Registration Authority. The leaflet shall also contain declaration about the non-use of prohibited ingredients in cattle feed, as specified by the committee on the specifications from time to time.

6.3 Each bag in which mineral mixture is packed shall contain a printed leaflet, format of which shall be approved by the Registration Authority, indicating batch number, date of manufacture, address of manufacturer, registration number, per cent of various mineral elements, mineral salts used and such other particulars as may be stipulated by the Registration Authority. The leaflet shall also contain declaration about the non-use of certain mineral salts and ingredients of animal origin.

6.4 The language of labeling on bags and on the printed leaflets shall be in Nepali/English language;

6.5 The labels or marks shall not contain any statement, claim, design or device which is false or misleading in any particulars concerning the cattle feed and mineral mixture contained in a package or the quantity or the value of such feed or the place of its origin;

6.6 No person shall manufacture and/or market Proprietary Cattle Feed or Mineral Mixture without the prior written approval of the Registration Authority.

7. Powers of Registration Authority:

7.1 The Registration Authority or any officer authorized by it in this behalf, may with a view to securing compliance with these Rules or to satisfy himself that all the provisions of the Rules has been complied with;

7.1.1 Collect samples of Compounded Cattle Feed, Calf Starter, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures or any ingredient used for production of these products kept for sale.

7.1.2 require the owner, occupier or any other person in charge of any place of business in which he has reason to believe that any contravention of the provisions of this Order or of the conditions of registration certificate issued there under has been, is being or is about to be committed, to produce any book, accounts or other documents showing transactions relating to such contraventions and take or cause to be taken extract or copies of such book, accounts or other documents produced before him;

7.1.3 enter, inspect and search any place of business or premises in which he has reason to believe that any contravention of the provisions of this Order or of the conditions of registration certificate issued there under has been, is being, or is about to be committed;

7.1.4 Search and seize the sample from the stocks of cattle feed, concentrates and mineral mixture manufactured/ stored for sale/distribution otherwise than in accordance with the provisions of these rules or of the conditions of registration certificate issued there under and thereupon take or authorize the taking of all measures necessary for securing the compliance of these rules.

7.2 When a sample is taken from the stock in the possession of a dealer, he shall be bound to give the name and such other particulars of the person on whose behalf such stock is held by him, as the Registration Authority or any officer authorized may require.

7.2.1 Every holder of a registration certificate shall be bound by any direction or order issued by the Registration Authority in pursuance of any of the provisions of these rules and shall comply with such direction or order and any failure on his part to comply with such direction or order shall be deemed to be a contravention of these rules.

7.2.2 The provisions of the Code of Criminal Procedure, ----------- (Act-- of …..) relating to search and seizure shall, so far as may be, apply to searches and seizures under this clause.

8. Sampling procedure

8.1 Registration Authority or any officer or a team of officers deputed by registration authority shall seize a sample of any product in the presence of the manufacturer/distributer or any person authorized by him, governed by these rules in accordance with the following procedure:

8.1.1 The selection of bags/tags shall be done in the following ratio:

Lot Size	No. of Bags to be selected
up to 50	1
51-100	3
101-300	4
301-500	5
501 and above	7

8.1.2 From the selected bags 1.500 Kg material from each bag should be taken out from the middle of bag. The material so collected should be accumulated on a clean & dry surface, it should be mixed properly, the mixed material should be filled in three plastic bags weighing 250 gms in each bag.

8.1.3 The mouth of the plastic bag shall be closed with the help of a hot seamer or burning candle. The closed plastic sample bags shall be placed in the cotton sample bag alongwith a copy of the sample seizure report. The mouth of the cloth bag shall be tied with a thread/sutli. Melted sealing wax shall be put on the knot of thread/sutli and the brass stamp shall be fixed on the sealing wax to leave the clear impression of the brass seal.

8.1.4 Sample seizure report shall be prepared by the officer/ incharge of the team of officers deputed for the seizure of sample of any product/commodity governed by these rules in the format given as Form-V.

8.1.5 The samples so sealed should be distributed as follows:

1. one of the three sealed parts of a sample should be sent to the Government Analytical Laboratory for analysis.
2. one of the three sealed parts of a sample should be handed over to the manufacturer/ dealer from whose premises sample has been seized.
3. one of the three sealed parts of a sample should be kept by the team leader of the sampling team.

9. Analysis of Samples

9.1 In-charge Govt. Analytical Laboratory (Maintained by Ministry of Agriculture and Livestock, Nepal) or any other laboratory identified by the registration authority shall cause the analysis of each sample received by the said laboratory in accordance with the standard procedure within a period of 15 days from the receipt of the sample and a report in the Performa given in FORM-VI shall be prepared and signed.

9.2 The sample analysis report so prepared shall be sent to the Registration Authority in duplicate.

9.3 Registration Authority shall send a copy of the sample analysis report to the concerned manufacturer/dealer (as the case may be).

9.4 The manufacturer/dealer if not satisfied with the result of the analysis report may request for reanalysis of the sample within a period of 30 days from the date of dispatch of analysis report.

9.5 Registration Authority shall get such a sample re-analysed from referral laboratory without disclosing the name of such laboratory to the concerned manufacturer/dealer at the cost of the manufacturer/ dealer.

9.6 The result of the re-analysis report given by the Referral Laboratory shall be final and binding both for the Registration Authority as well as manufacturer/dealer concerned.

10. **Penalty:**

10.1 The following acts of omission/commission shall constitute an offence under the Nepal Regulation of Cattle feed, Concentrates and Mineral Mixture Rules-2019 and rules made there under:

i. Manufacturing, storage, sale and/or distribution of Compounded Cattle Feed, Calf Starter Meal, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures without valid registration.

ii. Manufacturing, storage, sale and/or distribution of Compounded Cattle Feed, Calf Starter Meal, Calf Growth Meal, Proprietary Feed, Straw Based Feed, Concentrates and Mineral Mixtures not conforming to the prescribed specifications.

iii. Any violation of the conditions of registration and (or) directions of registration authority.

10.2 For each category of feed, standard deviation for each parameter shall be permissible as under:

Crude protein	±	0.5% unit
Ether extract	±	0.2% unit
Crude fiber	±	1.00 % unit
Sand silica	±	0.2 % unit
Urea	±	0.1 % unit
Calcium	±	0.1 % unit
Phosphorus	±	0.1 % unit
Available phosphorus	±	0.05 % unit
Vitamin A	±	100 I.U
Vitamin D3	±	50 I.U
Vitamin E	±	10 I.U

10.3 Registration Authority or an officer authorized by him shall lodge a complaint against the manufacturer/dealer committing any or all the above offences for trial in accordance with the provisions of the Nepal Regulation of Cattle feed, Concentrates and Mineral Mixture Rules-2019.

10.4 Registration Authority shall suspend the registration of the concerned manufacturer/dealer during the pendency of the case in the court of law.

10.5 Registration Authority shall cancel the registration of the manufacturer /dealer in case court of law holds him guilty of the offence.

10.6 Registration Authority shall withdraw suspension of the registration of the manufacturer /dealer in case court of law finds him not guilty.

10.7 Registration Authority shall take a cognizance if manufacturer/dealer contravenes any term & conditions of the registration not covered under 10.1 and fails to carry out his directions/orders/instructions and take penal action which may extend to the suspension/cancellation of registration subject to the condition that such order is not passed without affording adequate opportunity to the defaulter manufacturer/dealer of being heard to explain his position.

11. Maintenance of records:

11.1 The holder of registration certificate shall maintain record relating to his business specified below:

11.1.1 Manufacturer:

i. Stock Register of raw material showing the account of purchase and use of different ingredients.

i. Daily production register.
ii. Stock Register of manufactured products showing the account of quantities of different products manufactured, sold and distributed to the dealers.
iv. Dealer wise ledger account.
v. Quality analysis register showing analysis results of manufactured products and raw material used therein.

11.1.2 Dealer:

i. Purchase file showing the receipt of stock from the manufacturer under the registration.
ii. Stock Register showing the receipt and sale of each product received from the manufacturer under the registration.

11.2 The record maintained as above by the manufacturer/dealer (as the case may be) shall be made available to the registration authority or his authorized officers for inspection as and when asked for.

12. Submission of returns:

Every holder of registration certificate shall submit a yearly return in duplicate in respect of each class of cattle feed and mineral mixture manufactured or processed by him, in Form "VII".

FORM-I

(see Clause 4)

Application for Registration as a Manufacturer under "The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019"

1.	Name of the Applicant Firm/Company/ Association of persons/Person Address: Telephone No: Mobile No.: FAX No: email ID: ID proof of the applicant:	
2.	Type of Organization, Composition & Documentary proof thereof	
3.	Date of establishment of the firm	
4.	GST Numbers	
5.	Name of the authorized signatory	
6.	Area	Total area Roofed area Store area out of roofed area
7.	Details of the machinery installed alongwith their cost	As per the attachment.
8.	Items manufactured under the act	
9.	System of in plant quality components	
10.	Whether registered as Small Scale Industry or not? (attach proof)	
11.	Whether NOC from Govt. Pollution Control Board has been obtained? (attach proof)	
12.	Whether Trade Mark (attached proof)	
13.	Approximate sale price of each item	
14.	Production capacity/ per day	
15.	Actual production at the time of applying for registration	
16.	Mode of submitting fees *(give Details)*	
17.	Staff: Skilled/ un skilled workers Technically qualified Supervisory Inspectorate	
18.	Photos of the premises attached.	

PLACE: **(Signature of Manufacturer)**
DATED:

FORM-I (a)

(see Clause 4)

SELF DECLARATION

(for Registration as a Manufacturer under Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019)

I .... son of Sh .... resident of .... hereby self declare as under:

1. I have applied to the Ministry of Agriculture and Livestock, Nepal for registration under "the Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture Rules" to manufacture compounded cattle feed/ concentrates/ mineral mixture.
2. I/we .... is/are the owner/ sole proprietor/ partners of the firm M/s ....
3. I or Sh .... son of Sh ....; resident of .... is nominated as authorized signatory on the behalf of the firm/ company for all types of correspondences/ communications with the department.
4. The details of machinery installed in our production unit along with cost is given below:

S. No.	**Installed Machinery/ equipment**	**No. of equipment**	**Cost** *(in Rs.)*
i.	Mixer		
ii.	Grinder		
iii.	Elevator		
iv.	Pelleting machine		
v.	Molasses tank		
vi.	Motor (electric)		
vii.	Expeller/ Kolhu		
viii.	Oil filter & Oil storage tank		
ix.	Sealing machine/s		
x.	Weighing machine/s		
xi.	Quality control lab		
xii.	Any other		

5. The electricity connection is of .... KW in the name of Sh/ M/s ....
6. The total area of the unit is .... sqft; leased/ rented/ CLU is obtained in the name of Sh ....
7. The sign board depicting the firm/ unit to be registered is fixed/ shown outside of the premises.
8. No other industry will operate in the premises mentioned at s. no. 6 above.
9. I/we shall use high quality mineral mixture (as per Nepal specifications) @ 2% in the production of compounded cattle feed.

10. I/ we shall maintain records of stock register/ bills on any kind of sale/ purchase of raw material/ production etc.
11. The firm/ unit to be registered shall use the trade marks/ brands registered/ obtained from Trade Mark Authority.
12. I/we shall distribute/sell to those dealers/retailers; who have got registered with the …………………. under the provisions of these rules.
13. The firm/unit to be registered shall use printed bags for packaging as per department guidelines.
14. I/we have read "the Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules" thoroughly and is/are bound to obey each and every clause of the Rules. The department has full right to cancel my registration certificate if found violating the Rules.

Signature
(Deponent)

I hereby self-declare that the above mentioned statements from s. no. 1 to 15 are true to the best of my knowledge and nothing is kept secret.

Signature
(Deponent)

FORM-I (b)

(see Clause 4)

Inspection Report for Registration as a Manufacturer under "The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019"

1.	Date of Inspection	
2.	Name of Firm	
	Name of Sole proprietor/ Partners	
	Correspondence address	
	Contact No.	
	Email ID	
	ID proof of the applicant	
3.	Date of establishment of the Firm	
4.	Details of machinery installed. *(including costs)*	
5.	Status of sign board shown outside of the Unit.	
6.	Details of products to be manufactured for which Registration required.	
7.	Total area (in Sq. ft) of the Unit. Area (in Sq. ft) used for production purposes. *(also mention name/s of owner/s of land)*	
8.	Details of Brand registered	
9.	Details of equipment installed in laboratory (attach separate list)	
10.	Whether firm/ unit is registered under Small Scale Industries Department.	
11.	Whether unit falls under density of population? *(if yes, whether NOC from Nepal Pollution Control Board is obtained)*	
12.	Distance of firm/ unit from main road.	
13.	Details of prices of finished products. *(rate per quintal)*	
14.	Whether the firm is manufacturing finished products as per Department guidelines.	
15.	Manufacturing capacity of the unit. *(in tone per day)*	
16.	Details of electricity connection. By whom name the connection obtained: Electricity load *(in KW):*	Name: Load: .... KW
17.	Details of working staff.	
18.	Details of mineral mixture used. Name of firm, who manufacture mineral mixture: %age of mineral mixture used:	
19.	Whether LSP is used in the manufacturing of compounded cattle feed?	
20.	Whether Urea is used in the manufacturing of compounded cattle feed? *(if yes, %age of urea used)*	

21.	Details of storage of raw materials/ finished products.	
22.	Attach self addressed envelop of the firm.	
23.	Proposal of the Inspection Team. Team members (*with rubber stamp*) Team Leader (*with rubber stamp*)	

FORM-II

(see Clause 4)

Application for Renewal of Registration as a Manufacturer under The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019.

1.	Name of the registered manufacturer/ firm	
	Name of Firm	
	Name of Sole proprietor/ Partners	
	Correspondence address	
	Contact No.	
	Email ID	
	ID proof of the applicant	
2.	Date of Registration & RC No.	
3.	No. of quality tests performed during the preceding year.	
4.	Whether facility of quality control availed from the laboratory, if yes give no. of tests carried out.	
5.	Whether found guilty of any contravention of any provision of the Regulations of the Rules, if yes give details	
6.	Quantity of each products manufactured	
7.	Any addition made in the facilities of quality testing in the premises of manufacturer during the preceding year	
8.	Mode of submitting fees for Registration along with details.	
9.	State, if renewal is required for all the products as specified in the previous registration. state separately, if an alteration is required to be made.	

PLACE: **(Signature of Manufacturer)**
DATE:

FORM-II (a)

(see Clause 4)

SELF-DECLARATION

(for Renewal of Registration as a Manufacturer under Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019)

I .... son of Sh ....
Resident of ....
....
hereby self-declare as under:

1. I have applied to the Ministry of Agriculture and Livestock, Nepal for renewal of my registration under "the Nepal Regulation of Compounded Cattle Feed, Concentrates & Mineral Mixture Rules" to manufacture
……
2. I/we .... is/are the owner/ sole proprietor/ partners of the firm M/s ....
3. I or Sh .... son of Sh ....; resident of .... is nominated as authorized signatory on the behalf of the firm/ company for all types of correspondences/ communications with the department.
4. The details of machinery installed in our production unit along with cost is given below:

S. No.	**Installed Machinery/ equipment**	**No. of equipment**	**Cost** *(in Rs.)*
i.	Mixer		
ii.	Grinder		
iii.	Elevator		
iv.	Pelleting machine		
v.	Molasses tank		
vi.	Motor (electric)		
vii.	Expeller/ Kolhu		
viii.	Oil filter & Oil storage tank		
ix.	Sealing machine/s		
x.	Weighing machine/s		
xi.	Quality Control Lab		
xii.	Any other		

5. The electricity connection is of .... KW in the name of Sh/ M/s ....
6. The total area of the unit is .... sqft; leased/ rented/ CLU is obtained in the name of Sh ....
7. The sign board depicting the firm/ unit to be registered is fixed/ shown outside of the premises.
8. No other industry will operate in the premises mentioned at s.no. 6 above.
9. I/we shall use high quality mineral mixture (as per Nepal specifications) @ 2% in the production of compounded cattle feed.
10. The manufacturing capacity of the firm is ………………..per day.

11. I/ we shall maintain records of stock register/ bills on any kind of sale/ purchase of raw material/ production etc.
12. The registered firm/unit to be shall use ……………… as Trade Mark/ Brand; which got registered with Trade Mark Authority.
13. I/we shall distribute/sell to those dealers/retailers; who have got registered with the Deptt. of Dairy Development under the provisions of these rules.
14. The firm/unit to be registered shall use printed bags for packaging as per department guidelines.
15. I/we have read "the Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019" thoroughly and is/are bound to obey each and every clause of the Order. The department has full right to cancel my registration certificate if found violating the Rules.
16.

Signature
(Deponent)

I here by self declare that the above mentioned statements from s. no. 1 to 15 are true to the best of my knowledge and nothing is kept secret.

Signature
(Deponent)

FORM-II (b)

(see Clause 4)

Inspection Report for Renewal of Registration as a Manufacturer under "The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019"

1.	Date of Inspection	
2.	Name of Firm (Complete Address)	
	Name of Sole proprietor/ Authorized person	
	Correspondence address	
	Contact No.	
	Email ID	
	ID proof	
3.	Date of establishment of the Firm	
4.	Details of machinery installed. *(including costs)*	
5.	Status of sign board shown outside of the Unit.	
6.	Whether renewal of RC required for the manufacturing of same products or any change is required?	
7.	Total area (in Sq. ft) of the Unit. Area (in Sq. ft) used for production purposes. *(also mention name/s of owner/s of land)*	Total area--- Covered area--- Uncovered area---
8.	Details of Brand/s registered.	
9.	Details of equipments installed in laboratory.	
10.	Whether firm/ unit is registered under Small Scale Industries Department.	
11.	Whether unit falls under density of population? *(if yes, whether NOC from Nepal Pollution Control Board is obtained)*	
12.	Distance of firm/ unit from main road.	
13.	Details of prices of finished products. *(rate per quintal)*	
14.	Year wise details of the last 3 years. Production/ Distribution/ Sale:	
15.	Manufacturing capacity of the unit. *(in tonn per day)*	
16.	Details of electricity connection. By whom name the connection obtained: Electricity load *(in KW):*	Name: Load: .... KW
17.	Details of working staff.	
18.	Details of mineral mixture used in the production of cattle feed. Name of firm, who manufacture mineral mixture: %age of mineral mixture used:	
19.	Whether sufficient and separate space for material and finished products is available at site.	
20.	Whether control program for present rodent is in Place?	
21.	Any violation of rules in the last three years.	
22.	Details of no. of samples drawn for quality test for the last 3 years. *(details of passed/ failed samples)*	
23.	Whether bags used for packaging of finished products are printed as per Department guidelines? *(if yes, %age of urea used)*	
24.	Proposal of the Inspection Team. **Team members** *(with rubber stamp)*	**Team Leader** *(with rubber stamp)*

FORM-III

(see Clause 4)

Application for Registration as a Dealer for sale/distribution of Compound Cattle feed, Concentrates & Mineral Mixture under "the Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019"

1.	Name and complete correspondence address of applicant Address: Telephone No: Mobile No.: FAX No.: email ID: ID proof of the applicant:	
2.	Name & complete Address of the retail outlet/Firm	
3.	Date of establishment	
4.	Area of the premises of the Dealer *(whether owned/ rented/ on lease)*	
5.	ID proof of the applicant.	
6.	Items to be sold along with Brand name and the manufacturer, with complete address along with RC no. under the rules.	
7.	Mode of submitting fees *(give Details)*	
8.	Stock position	
9.	Bill Book details	

Dated: **(Signature of Dealer)**

FORM-IV

(see Clause 4)

Application for Renewal of Registration as a Dealer for sale/distribution of Compounded Cattle feed, Concentrates & Mineral Mixture under "the Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019"

1.	Name of the applicant alongwith Father's Name & Address. Address: Telephone No: Mobile No.: FAX No.: email ID: ID proof of the applicant:	
2.	Name & Address of the Registered Firm	
3.	Date of first Registration and RC No.	
4.	No. of quality tests done by registering authority.	
5.	Whether facility of quality control availed from the laboratory, if yes no. of tests carried out	
6.	Items sold alongwith Brand name and the manufacturer and quantity of cattle feed, Mineral Mixture and concentrates sold during the last three years.	
7.	Stock position	
8.	Mode of submitting fees *(give Details)*	

Dated: **(Signature of Dealer)**

FORM-V

(see Clause 8)

Ministry of Agriculture and Livestock, Nepal

SEIZURE REPORT

Particulars of Samples drawn of Compounded Cattle Feed Concentrate and Mineral Mixture under The Nepal Regulation of Compounded Cattle feed, Concentrates and Mineral Mixtures Rules-2019.

1. Dated of Sampling
   …………………………………………………………

2. Serial No/Code of Sample
   ………………………………………………………..

3. Name and Address of dealer* from the
   …………………………………………………………
   Premises of which sample drawn
   …………………………………………………………

   …………………………………………………………

4. Whether manufacture or Seller or Distributor
   ……………………………………………………………

5. Registration Certificate Number (Valid up to)
   …………………………………………………………..

6. i) Type and grade of compounded cattle
   ……………………………………………………………
   Feed/Concentrate/mineral mixture and brand
   ……………………………………………………………
   Name of which sample has been drawn.
   …………………………………………………………..

   ii) Name of the Manufacturer
   ……………………………………………………………
   (in case of seller/distributor)
   ……………………………………………………………

   iii) Lot No. date & month of manufacturing
   ……………………………………………………………
   of the feed/concentrated/ Mineral Mixture
   …………………………………………………………..
   of which sample drawn
   ……………………………………………………………

iv) Composition prescribed on the bag(s)
………………………………………………………………

7. Stock position of lot from which sample has
………………………………………………………………
been drawn.

8. Physical condition of compounded cattle
………………………………………………………………

Feed/ Concentrate/ Mineral Mixture.
……………………………………………………………….

9. Whether sample drawn from open or stitched bags
………………………………………………………………

10. Name and designation of Officer/ Officials
……………………………………………………………….
Authorized to drawn sample by Registration
……………………………………………………………….
Authority under provision of the Rules
……………………………………………………………….

……………………………………………………………….
Witness

Signature and Metallic Seal of Authorized Officer

Certified that the sample of compounded cattle feed/ concentrate and mineral mixture has been drawn from the stock in my possession and I have signed the test sample at the time of sealing. I have also received on test sample out of the three samples prepared.

Receipt of Manufacture/Dealer
Signature of Manufacture/Dealer*
Signature and Seal of Authorized Office — or his Representative with address.
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………

*_as defined in Section …………………………. of the Rules_

FORM-VI

(see Clause 8)

Communication of Result of Sample

Ministry of Agriculture and Livestock, Nepal

Office: Chief Chemist-cum-In-charge, Govt. Analytical Laboratory, …………………

To,

Registering Authority/Director
Ministry of Agriculture and Livestock,
Nepal

No.: Dated:

Subject: **Analysis Report.**

Reference: Letter No. …………………………………………, dated ……………………..…….. of Dy. Director, Dairy/ Dairy Dev. Officer ……………………………………………

In response to the subject/ reference cited above Dy. Director, Dairy/ Dairy Dev. Officer submitted a sample for analysis from the laboratory as per details given below:

Sample Code No.: …………………………………….
Date of receipt of the sample: …………………..……………….
Recoding done by this Office: …………………………………….
Quantity of sample received: ………………….……… Grams
……………………. A sample no.: ………………………, dated

Analysis report is as per details given below:

S. No.	Contents	Standards as per Nepal Govt.	Analysis Report
1.	Moisture (max.)		
2.	Crude Protein (min.)		
3.	Crude Fat (min.)		
4.	Crude Fiber (max.)		
5.	Acid insoluble ash (max.)		
6.	Salt (as NaCI), per cent by mass, Min.		
7.	Calcium (as Ca) per cent by mass, Min.		
8.	Total phosphorus, per cent by mass, Min.		
9.	Available phosphorus, %ag by mass, Min.		
10.	Urea, per cent by mass, Max.		

11.	Calcite powder, pre cent by mass Max.		
12.	Vitamin A, I.U./kg, Min.		
13.	Vitamin D, I.U./kg, Min.		
14.	Vitamin E, I.U./kg, Min.		
15.	Aflatoxin B1 (ppb), Max.		
16.	Total ash (max.)		

Note: 1) The contents mentioned in S. No. 2 to 5 above are on dry basis.
2) The seals were found intact at the time of receiving of sample in the laboratory.

Chief Chemist-cum-Incharge,
Govt. Analytical Laboratory,
…………………..

FORM-VII

(see Clause 8)

Ministry of Agriculture and Livestock, Nepal

----------------------Full Address

email ID: ministry agl@rediffmail.com

To,

M/s …………………………………………………………

……………………………………………………………..

………………………………………………………………

No.: Dated:

Subject: **Analysis Report of sample drawn under *"The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules-2019.***

A sample no.: ………………………, dated ……………………….. was drawn by the sampling team as authorized by the undersigned under the *"The Nepal Regulation of Compounded Cattle feed, Concentrates & Mineral Mixture Rules".* The analysis report from Govt. approved laboratory is given below:

Sl. No.	**Variation**	**Standards of Nepal Govt.**	**Analysis Report**
1.	Moisture (max.)		
2.	Crude Protein (min.)		
3.	Crude Fat (min.)		
4.	Crude Fiber (max.)		
5.	Acid insoluble ash (max.)		
6.	Urea		
7.	Total ash (max.)		

The analysis report shown above of your sample is as per prescribed standards/ not as per prescribed standards.

Registration Authority-cum,
Director,
MA&L, Nepal**.**

No. Dated:

The copy of above is forwarded to Team Leader/ Dy. Director, Dairy ………………………. for information.

Registration Authority-cum,
Director,
MA&L, Nepal**.**

Annexure A
SPECIFICATIONS
(See Clause No.13.1)

Cattle Feed

Sl.No.	Characteristic	Requirement				Method of Test (Ref to)
		Type-A ***Printing Green Colour***	Type-B ***Printing Blue Colour***	Type-C ***Printing Yellow Colour***	Type-D ***Printing Black Colour***	
1.	Moisture, percent by mass, Max.	11	11	11	11	Cl. No.4 of IS 7874, Part 1:1975
2.	Crude protein (N x 6.25), percent by mass, Min.	25	22	20	18	Cl. No. 5 of IS 7874, Part 1:1975
3.	Crude fat, percent by mass, Min.	4.5	4.0	2.5	2.0	Cl. No. 7 of IS 7874, Part 1:1975
4.	Crude fibre, percent by mass, Max.	8	10	12	15	Cl. No.8 of IS 7874, Part 1:1975
5.	Acid insoluble ash, percent by mass, Max.	3.0	3.0	4.0	5.0	Cl. No.10 of IS 7874, Part 1:1975
6.	Common salt (as NaCl), per cent by mass, Min.	1.0	1.0	1.0	1.0	Cl. No. 4 of IS 7874 (Part 2):1975
	Common salt (as NaCl), per cent by mass, Max.	1.0	1.0	1.0	1.0	
7.	Calcium (as Ca) per cent by mass, Min.	1.0	0.8	0.8	0.8	IS 13433 (Part 1/Part 2:1992
8.	Total phosphorus, per cent by mass, Min.	0.8	0.5	0.5	0.5	Cl.No.6 of IS 7874 (Part 2): 1975 or [1]IS 14828: 2000
9.	Available phosphorus, per cent by mass, Min.	0.25	0.25	0.25	0.20	IS 1374:1992 ANNEX C
10.	Urea, per cent by mass, Max.	1.0	1.0	1.0	1.0	IS:7874 (Part 1) General Methods
11.	Calcite powder, per cent by mass, Max.	1.0	1.0	1.0	1.0	IS 13433 (Part 1/Part 2:1992
12.	Vitamin A, I.U./kg, Min.	10,000	7000	7000	7000	ISO 14565: 2000
13.	Vitamin D_3, I.U./kg, Min.	1500	1200	1200	1200	Annex E of IS 2052:1979
14.	Vitamin E, I.U./kg, Min.	50	30	30	30	Annex F of IS 2052:1979
15.	Aflatoxin B_1 (ppb), Max.	20	30	40	50	Annex G[2] of IS 2052:2009 or IS 13427: 1992

Note 1: The values for requirements (2) to (15) are on moisture-free basis.

Note 2: For routine analysis, the characteristics mentioned above may be tested by near infra-red analyzer (NIR). However, in case of dispute, the method given above shall be the referee's method.

Note 3: [1]IS14828:2002 shall be the referee's method, in case of dispute.

[2]In case of dispute, HPLC method shall be the referee's method. (Adopted from Indian Standards)

FORMAT OF PRINTED LEAFLET

(See Clause No.15 (2) - Packing, Marking & Labeling)

<table>
<tr><td>(ii) Cattle feed Type of Feed:</td><td>Date of Manufacture:</td></tr>
<tr><td>Name and Address of Manufacturer:</td><td>Registration Number:</td></tr>
<tr><td>Batch No.</td><td>Net Weight:</td></tr>
<tr><td colspan="2">Nutrient composition</td></tr>
<tr><td colspan="2">Moisture, percent by mass, Max.</td></tr>
<tr><td colspan="2">Crude protein (N x 6.25), percent by mass, Min.</td></tr>
<tr><td colspan="2">Crude fat, percent by mass, Min.</td></tr>
<tr><td colspan="2">Crude fibre, percent by mass, Max.</td></tr>
<tr><td colspan="2">Acid insoluble ash, percent by mass, Max.</td></tr>
<tr><td colspan="2">Salt (as NaCl), per cent by mass, Max.</td></tr>
<tr><td colspan="2">Calcium (as Ca) per cent by mass, Min.</td></tr>
<tr><td colspan="2">Total phosphorus, per cent by mass, Min.</td></tr>
<tr><td colspan="2">Available phosphorus, per cent by mass, Min.</td></tr>
<tr><td colspan="2">Vitamin A, I.U./kg, Min.</td></tr>
<tr><td colspan="2">Vitamin D_3, I.U./kg, Min.</td></tr>
<tr><td colspan="2">Vitamin E, I.U./kg, Min.</td></tr>
<tr><td colspan="2">Aflatoxin B_1 (ppb), Max.</td></tr>
<tr><td>This feed contains :
• Urea:______________
• Mineral mixture:___________
• Common salt:_______________
• Calcite powder:_____________</td><td>List of ingredients used in manufacturing this feed:
1.
2.
3.
4.
5.
6.</td></tr>
<tr><td colspan="2">This feed does not contain ingredients, such as, rice husk, mahua cake, castor husk/meal, salseed meal, jatropha cake/meal, saw dust and animal origin feed ingredients.</td></tr>
</table>

Annexure B
SPECIFICATIONS
(See Clause No.13.1)

Calf starter and calf growth meal for young stock

Sl.No.	Characteristic	Requirement		Method of Test (Ref to)
		Calf starter meal	Calf growth meal	
1.	Moisture, percent by mass, Max.	10	10	Cl. No.4 of IS 7874, Part 1:1975
2.	Crude protein* (N x 6.25), percent by mass, Min.	23	22	Cl. No. 5 of IS 7874, Part 1:1975
3.	Crude fat, percent by mass, Min.	4.0	3.0	Cl. No. 7 of IS 7874, Part 1:1975
4.	Crude fibre, percent by mass, Max.	7	10	Cl. No.8 of IS 7874, Part 1:1975
5.	Acid insoluble ash, percent by mass, Max.	2.5	3.5	Cl. No.10 of IS 7874, Part 1:1975
6.	Common salt (as NaCl), per cent by mass, Min.	1.0	1.0	Cl. No. 4 of IS 7874 (Part 2):1975
	Common salt (as NaCl), per cent by mass, Max.	1.0	1.0	
7.	Calcium (as Ca) per cent by mass, Min.	0.5	0.5	IS 13433 (Part 1/Part 2:1992
8.	Total phosphorus, per cent by mass, Min.	0.5	0.5	Cl.No.6 of IS 7874 (Part 2): 1975 or [1]IS 14828: 2000
9.	Available phosphorus, per cent by mass, Min.	0.2	0.2	ANNEX C of IS 1374:1992
10.	Vitamin A, I.U./kg, Min.	10,000	10,000	ISO 14565: 2000
11.	Vitamin D_3, I.U./kg, Min.	2,000	2,000	Annex E of IS 2052:1979
12.	Vitamin E, I.U./kg, Min.	150	150	Annex F of IS 2052:1979
13.	Aflatoxin B_1 (ppb), Max.	20	20	Annex G[2] of IS 2052:2009 or IS 13427:1992

Note 1: The values for requirements (2) to (13) are on moisture-free basis.
Note 2: *While analyzing for crude protein, it should be ensured that the nitrogen has not been derived from urea or other ammonium salts.
Note 3: [1]IS14828:2000 shall be the referee's method, in case of dispute.
[2]In case of dispute, HPLC method shall be the referee's method. (Adopted from Indian Standards)

FORMAT OF PRINTED LEAFLET

(See Clause No.15 (2) - Packing, Marking & Labeling)

<table>
<tr><td>(i) Young stock Type of Feed:</td><td>Date of Manufacture:</td></tr>
<tr><td>Name and Address of Manufacturer:</td><td>Registration Number:</td></tr>
<tr><td>Batch No.</td><td>Net Weight:</td></tr>
<tr><td colspan="2">Nutrient composition</td></tr>
<tr><td colspan="2">Moisture, percent by mass, Max.</td></tr>
<tr><td colspan="2">Crude protein (N x 6.25), percent by mass, Min.</td></tr>
<tr><td colspan="2">Crude fat, percent by mass, Min.</td></tr>
<tr><td colspan="2">Crude fibre, percent by mass, Max.</td></tr>
<tr><td colspan="2">Acid insoluble ash, percent by mass, Max.</td></tr>
<tr><td colspan="2">List of ingredients used in manufacturing this feed :
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.</td></tr>
<tr><td colspan="2">This feed does not contain urea or any other non-protein nitrogen compounds including ammonium salts.
This feed does not contain ingredients, such as, rice husk, mahua cake, castor husk/meal, salseed meal, jatropha cake/meal, saw dust and animal origin feed ingredients.</td></tr>
</table>

Annexure C

Proprietary Feed

BYPASS FAT SUPPLEMENT FOR CATTLE – SPECIFICATION

Table 1: Requirement for bypass fat supplement for feeding dairy animals

Sl. No.	Characteristic	Requirement		Method of test, refer to
		CaLCFA-80	BF-99	
1.	Moisture, per cent by mass (Max.)	5.0	1.0	Annex A of IS 5470
2.	Total fat, per cent by mass (Min.)	80.0	99.0	7 of IS 7874 (Part 1)
3.	Calcium, per cent by mass (Min.)	7.0	--	IS 13433 (Part 1/Part2)
4.	Degree of protection, per cent by mass (Min.)	75.0	--	Annex-I
Note: The requirements at Sl. No. 2 and 4 are on moisture free basis.				

[Sl. No. (4)]

ANNEX-I

IN VITRO DETERMINATION OF DEGREE OF PROTECTION IN BYPASS FAT SUPPLEMENT

1. Equipment:

1.1 Stoppered ground glass 15 & 30 ml test tubes
1.2 Suba seals
1.3 Wide rubber bands
1.4 Vortex mixer
1.5 Solvent, acid and caustic dispensers and precision pipettes
1.6 Nitrogen evaporator
1.7 Nitrogen gas cylinder
1.8 Thermostatically controlled orbital shaking incubator plus black cloth to use as a cover
1.9 Thermostatically controlled heating block to fit 15 ml tubes
1.10 Laboratory oven
1.11 Pasteur pipettes

2. Procedures:

2.1 Weigh 130 mg of protected lipid, untreated lipid, known standards and blanks. This should be done a day in advance, and tubes stored in the refrigerator.
2.2 Pipette 10 ml of strained rumen fluid into test tube.
2.3 One tube from each sample remains un-incubated (zero hour). Proceed to the saponification step with these.
2.4 Flush the remaining duplicate sample sets with nitrogen using a Pasteur pipette attached to a gas cylinder via a rubber tubing.
2.5 Cap with Suba seals and seal tightly with rubber bands to maintain anaerobic conditions.
2.6 Incubate samples in a shaking incubator at 38^{o}C for 24 hours.

2.7 Remove at the end of incubation, allow to cool, and carefully remove Suba seals, Proceed to the saponification step.

3. Saponification:

3.1 Add 2 ml of Ethanol

3.2 Add 2 ml of 5N Sodium Hydroxide (NaOH).

3.3 Shake well and cover with foil.

3.4 Place into oven @ 80^{o}C for 1.5-2h.

3.5 Remove from oven

3.6 Allow to cool.

4. Acidify:

4.1 Add 5 N Hydrochloric Acid (HCL) approx. 2 ml.

4.2 Invert test tube with care.

4.3 pH must be checked for each sample using pH paper till acid (must be pink)

4.4 When sample has cooled sufficiently

4.5 Extract fatty acids – add 4 ml of petroleum ether, shake well, pipette the supernatant into a labeled 15 ml test tube.

4.6 Repeat above step – pooling the extracts

4.7 Evaporate pooled petroleum ether (PE) extracts to dryness in a warm water bath under a stream of nitrogen.

5. Methylate:

5.1 To the dried sample add 3 ml of 1% sulphuric Acid in Methanol (freshly made).

5.2 Reflux on a heating block at 50-60^{o}C for 1.5 h.

5.3 Add 3 ml of 5% NaCl (salt solution).

5.4 Add 2 ml of PE.

5.5 Cool, shake well.

5.6 Centrifuge at 2000 rpm for 3 minutes or allow to stand until phases clear.

5.7 Decant supernatant into GLC vial and cap.

5.8 Make sure sample vials are clearly labeled with number, date and name of operator.

5.9 Run on GLC.

6. Calculation:

$$\text{Protection (\%)} = \frac{\%\ C_{18:2}\ \text{after incubation}}{\%\ C_{18:2}\ \text{before incubation}} \times 100$$

References:

Gulati S.K. (1976). Protected triacylglycerol and sterol supplements for ruminants. MSc thesis, Macquarie University, North Ryde, NSW, Australia.

Gulati, S.K., Ashes, J.R. and Scott, T.W. (1977). Assessing the degradation of fat supplements in ruminants. Anim. Feed Sci. & Tech. 64:127.

BYPASS PROTEIN FEED FOR CATTLE – SPECIFICATION

Sl. No	Characteristic	Requirement	Methods of Test Refer to
1.	Moisture, percent by mass, *Max*.	11	4 of IS 7874 (Part 1)
2.	Crude protein (N x 6.25), percent by mass, *Min*	22	5 of IS 7874 (Part 1)
3.	Crude fat, percent by mass, *Min*	4	7 of IS 7874 (Part 1)
4.	Crude fibre, percent by mass, *Max*	10	8 of IS 7874 (Part 1)
5.	Acid insoluble ash, percent by mass, *Max*	3.0	10 of IS 7874 (Part 1)
6.	Rumen un-degradable protein(UDP), percent by mass, *Min.*	14	Annex 2
7.	Common salt (as NaCl), percent by mass, *Max*	1.5	4 of IS 7874 (Part 2)
8.	Calcium (as Ca), percent by mass, *Min*	1.0	IS 13433 (Part 1/Part2)
9.	Available phosphorus (as P), percent by mass, *Min.*	0.3	Annex F of IS 1374
10.	Vitamin A, IU/kg, *Min*	10,000	IS 15120
11.	Vitamin D_3 IU/kg, *Min*	1,500	Annex E of IS 2052
12.	Vitamin E, IU/kg, *Min*	50	Annex F of IS 2052
13.	Aflatoxin B_1 (ppb), *Max*	30	IS 13427 or IS 14718#

NOTE : 1. The values for requirements (2) to (9) are on moisture free basis.
2. In case of dispute, test method indicated by # shall be the referee method. (Adopted from Indian Standards)

[Sl. No. (6)]

ANNEX-2

DETERMINATION OF RUMEN DEGRADABLE PROTEIN (RDP) AND RUMEN UNDEGRADABLE PROTEIN (UDP)

1 APPARATUS

1.1 Nylon bag;
1.2 Plastic tube;
1.3 Rubber band/nylon thread;
1.4 Hot air oven;
1.5 Washing machine;
1.6 Rumen cannulated animal

2 PROCEDURE

2.1 Preparation of Sample

2.1.1 Weigh 3.0g sample for dry feeds (hays, straw etc) or 5.0g sample for protein supplements and transfer it to nylon bag (35-50 µ pore size).

2.1.2 Record the weight of bag plus sample.

2.1.3 Attach the nylon bag to the respective plastic tubes for incubation and place them with bags in the rumen and tie the bags with cannula with a piece of nylon thread.

2.1.4 Incubat**e** the bags for 4, 8, 16, 24, 48, 72 and 96 h for roughage and for protein sample 2, 4, 8, 16, 24 and 48 h.

2.1.5 Withdraw the bags and immediately place in a bucket of cold water to prevent further fermentation and to wash off the feed particles adhering to the outside of the bags.

2.1.6 Transfer the bags in washing machine for 20 min for cold water washing. The bags could also be washed under running cold water in laboratory until the washing is clear.

2.1.7 Detach the nylon bags from the tubes by cutting the rubber bands.

2.1.8 Dry the bags at 60-65^0 C for 48h and weigh the bags immediately after drying.

3 Calculation

3.1	Empty bag weight	(W)
3.2	Bag + feed sample before incubation	(W_1)
3.3	Bag + residue after incubation	(W_2)
3.4	Percent dry matter in the feed sample	(DM%)
3.5	Sample dry matter weight	(W_1-W) x DM% = (W_3)
3.6	Residue dry matter weight	(W_2-W) = (W_4)

$$\text{DM disappearance (\%)} = \frac{W_3 - W_4}{W_3} \times 100$$

3.7 Degradation kinetics

The degradation kinetics of the incubated feedstuffs may be calculated by curvilinear regression of DM and other degradable components of the feed determined by nylon bag technique.

3.7.1 Potential degradability (P) = a + b (1-e^{ct})

Where,

a = y-axis intercept at time 0 that represents soluble and completely degradable substrate washed out of the bags (0h disappearance)

b = The difference between the intercept (a) and the asymptote that represents the insoluble but potentially degradable substrate

t = incubation time

c = The rate of disappearance of component 'b' per hour (rate constant)

a+b = The asymptote of the disappearance curve

1 – (a+b) = The undegradable portion of a sample

3.7.2 Effective degradability (E) = a + bc / (c + k)

Where, k = rumen small particle out flow rate.

The above equations assume that component 'b' disappears at a constant fractional 'c' per hour.

4. Near Infrared Analyzer (NIR) technique

Near Infrared Analyzer (NIR) can be used for measuring UDP values by developing equations with the nylon bag technique. However, in case of dispute nylon bag technique shall be considered as final.

Annexure D
Specifications
(See Clause no. 13)
Straw based feed

Sl.No.	Characteristic	Requirement	Method of Test (Ref to)
1.	Moisture, percent by mass, Max.	12	Cl. No.4 of IS 7874, Part 1:1975
2.	Crude protein (N x 6.25), percent by mass, Min.	10	Cl. No. 5 of IS 7874, Part 1:1975
3.	Crude fibre, percent by mass, Max.	28	Cl. No.8 of IS 7874, Part 1:1975
4.	Acid insoluble ash, percent by mass, Max.	8	Cl. No.10 of IS 7874, Part 1:1975
5.	Common salt (as NaCl), per cent by mass, Min.	0.5	IS 7874 (Part 2) 1975, Cl.No. 4
	Common salt (as NaCl), per cent by mass, Max.	0.5	
6.	Urea, per cent by mass, Max.	0.5	IS:7874 (Part 1) General Methods
7.	Calcite powder, per cent by mass, Max.	0.5	IS:13433 (Part I/Part 2: 1992)
8.	Vitamin A, I.U./kg, Min.	2,000	ISO 14565: 2000
Note: The values for requirements (2) to (8) are on moisture-free basis. (Adopted from Indian Standards)			

FORMAT OF PRINTED LEAFLET
(See Clause No.15 (2) - Packing, Marking & Labeling)

(iii) Straw based feed Name and Address of Manufacturer:	Registration Number:
Batch No. & Date of Manufacture	Net Weight:
Nutrient composition	
Moisture, percent by mass, Max.	
Crude protein (N x 6.25), percent by mass, Min.	
Crude fibre, percent by mass, Max.	
Acid insoluble ash, percent by mass, Max.	
Salt (as NaCl), per cent by mass, Max.	
Urea, per cent by mass, Max.	
Calcite powder, per cent by mass, Max.	
Vitamin A, I.U./kg, Min.	
This feed contains : • Urea:_____________ • Mineral mixture:__________	This feed contains following ingredients : 1. 2. 3. 4. 5. 6. 7.

Annexure E
MINERAL MIXTURE SPECIFICATIONS FOR NEPAL

Sl. No.	Characteristic	Requirement		Method of Test (Ref to)
		Plain MM	Chelated MM	
1.	Moisture (%), Max.	5.0	5.0	Annex-A of IS 5470:2002
2.	Calcium (%), Min.	20.0	18.0	IS 15121 or IS 13433 (Part 1) or IS 13574
3.	Phosphorus (%), Min.	12.0	10.0	IS 14828
4.	Magnesium (%), Min.	5.0	2.5	IS 15121 or IS 13574
5.	Sulphur (%), Min.	1.8	1.0	Annex B of IS 1664:2002
	Sulphur (%), Max.	3.0	1.5	
6.	Copper (%), Min.	0.10	**0.10***	IS 15121
7.	Zinc (%), Min.	0.80	**0.80***	IS 15121
8.	Manganese (%), Min.	0.12	**0.12***	IS 15121
9.	Iron (%), Min.	0.40	0.40	IS 15121
10.	Iodine (%), Min.	0.026	0.026	Cl. No. 8 of IS 7874 (Part 2)
11.	Cobalt (%), Min.	0.012	0.012	Cl. No. 11 of IS 7874 (Part 2)
12.	Chromium (%), Min.	0.004	**0.004***	IS 15121
13.	Fluorine (%), Max.	0.07	0.06	Annex B of IS 5470:2002
14.	Acid insoluble ash (%), Max.	3.0	3.0	Cl. No. 10 of IS 7874 (Part 1)

15.	Lead (ppm), Max.	30.0	30.0	A-7 of IS 1767
16.	Arsenic (ppm), Max.	10.0	10.0	A-6 of IS 1767
Note: The values for requirements (2) to (16) are on moisture-free basis. 50% of copper, zinc and manganese & 100% chromium requirement to be fulfilled through trace mineral glycinates, in case of chelated mineral mixture. Chelated mineral mixture is more effective for high yielding animals for improving reproduction efficiency and curing other mineral deficiency, as trace minerals are highly bioavailable in chelated mineral mixture.				

FORMAT OF PRINTED LEAFLET

(See Clause No.15 (3) - Packing, Marking & Labeling)

Mineral Mixture : Type of mineral mixture:	Date of Manufacture:
Name and Address of Manufacturer:	Registration Number:
Batch No.	Net Weight:
Mineral element composition	
Moisture (%), Max.	
Calcium (%), Min.	
Phosphorus (%), Min.	
Magnesium (%), Min.	
Sulphur (%)	
Copper (%), Min.	
Zinc (%), Min.	
Manganese (%), Min.	
Iron (%), Min.	
Iodine (%), Min.	
Cobalt (%), Min.	
Fluorine (%), Max.	
Acid insoluble ash (%), Max.	
Lead (ppm), Max.	
Arsenic (ppm), Max.	
Total ash (%)	
This mineral mixture contains the following mineral salts :	
This mineral mixture does not contain ingredients of animal origin such as meat & bone meal, bone meal, calcined bone meal, di-calcium phosphate of animal origin, etc. This mineral mixture does not contain marble powder, dolomite powder, ferric oxide, cupric oxide, manganese dioxide, unprocessed rock phosphate, etc.,	

Annexure- F

Requirements for Cottonseed Oilcake as Livestock Feed Ingredient

Sr. No	Characteristic					Method of Test, Ref to clause No. of IS 7874 (Part-1)
		Grade 1 Decorticated	Grade Decorticated	Grade Un-decorticated	Grade Un-decorticated	
1	Moisture, Percent by mass, Max	8.0	8.0	8.0	8.0	4
2	Crude protein (N X 6.25), percent by mass, Min	40.0	35.0	24.0	20.0	5
3	Crude fat or other extract, percent by mass, Min	7.0	6.0	7.0	5.0	7
4	Crude fibre, percent by mass, Max	12.0	15.0	22.0	26.0	8
5	Acid insoluble ash, percent by mass, Max	2.0	2.5	2.0	2.5	10
6	Castor husk or oilcake	Nil	Nil	Nil	Nil	11
7	Mahua oilcake	Nil	Nil	Nil	Nil	12

Note- The values specified for requirements (ii) to (v) are on moisture-free basis.
Methods of tests for animal feeds and feeding stuffs : Part I General methods.

Requirements for Coconut Oil cake as Livestock Feed Ingredient

Sr. No.	Characteristic	Requirement		Method of Test, Ref to clause No. of IS 7874 (Part-1)-1975*
		Type 1	Type ii	
1	Moisture, Percent by mass, Max	10.0	10.0	4
2	Crude protein (N X 6.25), percent by mass, Min	22.0	18.0	5
3	Crude fat or other extract, percent by mass, Min	6.5	11.0	7
4	Crude fibre, percent by mass, Max	12.0	10.0	8
5	Acid insoluble ash, percent by mass, Max	1.5	1.5	10

Note- The values specified for requirements (ii) to (v) are on moisture-free basis.
Methods of tests for animal feeds and feeding stuffs : Part I General methods.

Requirements for Maize Gluten Feed

Sr. No.	Characteristic	Requirement		Method of Test, Ref to clause No. of IS 7874 (Part-1)-1975*
		Type 1	Type ii	
1	Moisture, Percent by mass, Max	10	10	B
2	Crude protein (N X 6.25), percent by mass, Min	45	23	C
3	Crude fat percent by mass, Min	04	03	D
4	Crude fibre, percent by mass, Max	03	08	E
5	Acid insoluble ash, percent by mass, Max	0.5	0.5	G

Note- Requirements for characteristics (ii) to (v) are on moisture-free basis.

Requirements for WHEAT BRAN

Sr. No.	Characteristic	Requirement	Method of Test (Ref to App in of IS 2052-1968)
1	Moisture, Percent by weight, Max	12.5	B
2	Crude protein (Nitrogen X 6.25), percent by weight, Min	13.0	C
3	Crude fibre, percent by weight, Max	12	D
4	Acid insoluble ash, percent by weight, Max	0.25	E

Note- The Requirements for items (ii) to (iv) are on moisture-free basis.

Specification for compounded feeds for cattle (first revision)

Requirements for Rice Bran as Livestock Feed

Sr. No.	Characteristic	Requirement		Method of Test, Ref to clause No. of IS 7874 (Part-1)-1975*
		Type 1	Type ii	
1	Moisture, Percent by mass, Max	10	10	4
2	Crude protein (N X 6.25), percent by mass, Min	13	11	5
3	Crude fat percent by mass, Min	15	12	7
4	Crude fibre, percent by mass, Max	10	12	8
5	Acid insoluble ash, percent by mass, Max	05	08	10

Note- requirements for items (ii) to (v) are on moisture-free basis.

Methods of tests for animal feeds and feeding stuffs : Part I General methods.

Requirements for Mustard and rape seed oilcake as livestock feed ingredient

Sr. No.	Characteristic	Hydraulic/rotary or expeller Pressed Oilcake		Ghani or kohlu Pressed Oilcake	Method of Test, Ref to clause No. of IS 7874 (Part-1) 1975*
		Grade High fat	Grade Low fat		
1	Moisture, Percent by mass, Max	10.0	10.0	12.0	4
2	Crude protein (N X 6.25), percent by mass, Min	35.0	37.0	33.0	5
3	Crude fat or other extract, percent by mass, Min	8.0	5.0	12.0	7
4	Crude fibre, percent by mass, Max	9.0	10.0	7.0	8
5	Total ash, percent by mass, Max	8.0	9.0	8.0	9
6	Acid insoluble ash, percent by mass, Max	1.5	2.0	2.5	10

Note- The values specified for the requirements (ii) to (vi) are on moisture free basis.

Requirements for Linseed Oilcake as livestock feed ingredient

Sr No.	Characteristic	Hydraulic or expeller Pressed Oilcake		Ghani Pressed Oilcake	Method of Test, Ref to clause No. of IS 7874 (Part-1) 1975*
		Grade High fat	Grade Low fat		
1	Moisture, Percent by mass, Max	8.0	8.0	8.0	4
2	Crude protein (N X 6.25), percent by mass, Min	29.0	31.0	26.0	5
3	Crude fat or other extract, percent by mass, Min	8.0	5.0	15.0	7
4	Crude fibre, percent by mass, Max	10.0	10.0	6.0	8
5	Total ash, percent by mass, Max	8.0	8.0	9.0	9
6	Acid insoluble ash, percent by mass, Max	1.5	1.2	2.5	10
7	Castor husk or oilcake	Nil	Nil	Nil	11
8	Mahua Oilcake	Nil	Nil	Nil	12

Note- The values specified for the requirements (ii) to (vi) are on moisture free basis.

Requirements for Decorticated Groundnut Oilcake as livestock feed ingredient

Sr No.	Characteristic	Requirement		Method of Test, Ref to clause No. of IS 7874 (Part-1) 1975*
		Grade I	Grade II	
1	Moisture, Percent by mass, Max	8.0	8.0	4
2	Crude protein (N X 6.25), percent by mass, Min	48.0	43.0	5
3	Crude fat or other extract, percent by mass, Min	7.0	6.0	7
4	Crude fibre, percent by mass, Max	8.0	12.0	8
5	Acid insoluble ash, percent by mass, Max	2.0	2.5	10

Note- The values specified for the requirements (ii) to (vi) are on moisture free basis.
Methods of tests for animal feeds and feeding stuffs: Part 1 General method

Chapter 6

Strengthening of Feed Testing Laboratory for Testing Feed and Mineral Mixture Samples

1. INTRODUCTION

1.1. This chapter addresses internal laboratory quality control (QC), the purpose of which is to monitor performance, identify problems, and initiate corrective action. If project requirements are more stringent than typical laboratory QC criteria, the project manager and the laboratory should confer to see whether the laboratory can accommodate the project QC requirements.

1.2. Laboratory data should be produced under a quality system that incorporates planning, implementing, and internal assessment of the work performed by the laboratory, including QC.

1.3. A laboratory quality system should ensure that laboratory processes and measurements are in statistical control, which means that the distribution of measured results is stable. This chapter is to provide guidance to laboratory staff on those activities and professional practices.

1.4. The use of statistical techniques is the preferred method for implementing quality control in the laboratory. The chapter also identifies specific performance indicators, the principles that govern their use, indications and underlying causes of excursions, statistical means of evaluating performance indicators, and examples of root-cause evaluations.

1.5. Feed testing laboratory provides analytical facilities for different parameters in feed, fodder, feed supplements, mineral mixture etc.

2. LABORATORY SERVICES

2.1 Laboratory plays a vital role for providing following services:

2.1.1 Monitoring quality of feeds and fodder supplements

2.1.2 Testing of feed and fodder for macro and micro minerals including heavy metals

2.1.3 Supportive services for various agencies in the country

2.1.4 Conducting inter-laboratory Analytical Quality Control (AQC) exercises

2.1.5 Conducting training program

2.2 Feed Testing Laboratory could be set up in Kathmandu and would own by Ministry of Agriculture and Livestock.

2.2 Initially, scientists and technicians would be trained on the various laboratory techniques in different reputed laboratories involved in testing of feeds and feed supplements, including mineral supplements. Even, training could be provided in reputed laboratory in India.

3. TESTING FACILITIES

3.1 List of parameters to be tested under Feed Testing Laboratory from cattle feed, cattle feed raw materials, mineral mixture, mineral salts, vitamins, bypass protein supplement, bypass fat supplement, and fodders.

3.1.1 Moisture

3.1.2 Crude protein

3.1.3 Ether extract

3.1.4 Crude fibre

3.1.5 Total ash

3.1.6 Acid insoluble ash

3.1.7 Urea

3.1.8 Neutral detergent fibre (NDF)

3.1.9 Acid detergent fibre (ADF)

3.1.10 Rumen degradable protein (RDP)

3.1.11 Rumen un-degradalbe protein (UDP)

3.1.12 Total fat & bypass fat value

3.1.14 Fatty acid profiles

3.1.15 Iodine value in fat

3.1.16 Saponification number in fat

3.1.17 Density in degree brix in molasses

3.1.18 Sulphated ash in molasses

3.1.19 Total reducing matter in molasses

3.1.20 Calcium

3.1.21 Phosphorus

3.1.22 Magnesium

3.1.23 Sulphur

3.1.24 Sodium

3.1.25 Potassium

3.1.26 Copper

3.1.27 Zinc

3.1.28 Manganese

3.1.29 Iron

3.1.30 Cobalt

3.1.31 Selenium

3.1.32 Lead

3.1.33 Arsenic

3.1.34 Fluorine

3.1.35 Iodine

3.1.36 Aflatoxin B_1

3.1.37 Vitamins A, D_3 and E

3.1.38 Heavy metals

3.1.39 Fatty acid profile

4. INSTRUMENTATION

4.1 Following instruments should be required in Animal Nutrition Reference Laboratory

Sr. No.	**Instrument**	**Approx. cost (NPR in lakh)**
1	Analytical balance (2 nos.)	7.0
2	Pan balance	0.5
3	Hot plate	1.5
4	Hot air oven	1.0
5	Vacuum oven	2.0
6	Muffle furnace	1.5
7	Magnetic stirrer	0.5
8	Water bath shaker	1.5
9	Orbital mixer incubator	5.0
10	Centrifuge	1.0
11	Water purification system	10.0
12	Vaccum pump	1.5
13	Cyclotec sample mill	4.5
14	Kjeljec	15
15	Near infrared (NIR) analyzer	50
16	UV – Visible spectrophotometer	10
17	Atomic absorption spectrophotometer (AAS)	30
18	Ion analyzer	4.5
19	pH meter	1.5
20	Gas chromatograph (GC)	40
21	High performance liquid chromatography (HPLC)	50
22	Refrigerator	1.5
23.	Fibre tech	15
24.	Moisture analyzer	5
25.	Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES)	80
26.	Protein digester	5
27.	Fume chamber	10
28.	PDI meter	10
23.	Misc. instruments	10
Approximate total cost of instruments		**NPR 375 lakh**

4.2 LIST OF LABORATORY GLASS WARES AND PLASTIC WARES

Sr. No.	**Glassware**	**Unit price (NPR)**
1	Kjeldahi flasks, 800 ml. capacity, B-24/29	1000
2	Splash heads, spear shape, vertical side of cones at both ends, B-24	500
3	Condenser, B-24 socket at one side and B-24 cone at the other side	500
4	Oil flasks for ether extraction, joint B-24/29 capacity 150 ml	200
5	Extractors for soxhlet apparatus, cap. 60 ml.	750
6	Condensers with B-34 cone, for soxhlet apparatus	1000
7	Conical flaks 250 & 500 ml	250
8	Burettes capacity 50 x 1/10 ml	750
9	Pipettes, capacity – 1, 2, 5 & 10 ml	250
10	Automatic burette, 25 ml	5000
11	Glass test tubes with rims, O.D. x length 15 x 150 mm	450
12	Tripod stand, triangular, size 8” x 5”	100
13	Whatman filter papers No.1-12.5 cm & No. 40-12.5 cm	3000
14	Clamps, double burette, fisherman type	150
15	Washing bottles, capacity 500 ml	700
16	Whatman extraction thimbles made of cellulose, seamless, double thickness, size 20 x 80 mm (25 no.)	9000
17	Vacuum desiccator, 300 mm	1450
18	Volumetric flask, capacity – 25, 50, 100, 250, 500 & 1000 ml	1650
19	Porcelain mortar & pestle 250 mm diameter	1500
20	Glass marking pencils	150
21	Spatula, 6” length with one end spoon and other end flat, Stainless steel	50
22	Glass funnel plain, 7.5, 12.5 & 15.0 cm Funnel holder	700
23	Reagent bottles, capacity – 2000, 1000, 500, 250 & 125 ml	2000
24	Glass rod, cut size 5-9 mm diameter, round and polished edge, 30 cm. length.	50
25	Watch glasses, cut and polished edge with 5.0, 7.5 and 10.0 cm diameter	50
26	Rubber corks, acid and alkali proof, top diameter 14, 16, 19, 20, 30 and 39 mm	500
27	Glass beads 4 mm, white glass (500g)	650
28	Thermometers, mercury filled, engraved on steam 0-110 Deg. C x 1 Deg. C and 0 x 250 Deg.C x 1 Deg.C	150
29	S S tongs, length 20 cm	120
30	Porcelain gooch crucible, capacity 25 ml	100
31	Asbestos pads, 250 x 250mm	100
32	Glass beakers, capacity – 2000, 1000, 500, 150, 50 & 25 ml	1200
33	Flask conical, capacity – 100, 250, 500 & 1000 ml	500
34	Measuring cylinder, capacity – 25, 50, 100, 250, 500 & 1000 ml	3000
35	Vitrosil silica crucibles without lid, capacity 50 ml	700
36	Glass wash bottles with ground joints B-24, capacity 1000 ml	900

Sr. No.	Glassware	Unit price (NPR)
37	Extraction flasks, flat bottom wide mouth, capacity 1 litre, B-29, 34, 35	6000
38	Dropper bottles 30-60 ml	150
	Plastic wares	
39	Wash bottle, capacity 500 ml	100
40	Beakers, capacity 100 & 250 ml	80
41	Measuring Cylinders, capacity 50, 100, 250 & 500 ml	300
42	Centrifuge tube with cap, 7, 10 & 50ml	75
43	Rack for Centrifuge tubes	450
44	Funnel, 75 & 100mm	50
45	Pipettes stand	500
46.	Misc. glass wares	50,000
Total		**96,825**

4.3 LIST OF LABORATORY CHEMICALS

Sr. No.	Chemicals	Unit size	Unit price (NPR)
1	Acetic acid	2.5 lit	1000
2	Acetone	2.5 lit	1500
3	Acetonitrile	2.5 lit	5000
4	Ammonium carbonate {$(NH_4)_2$ CO_3}	500 gm	500
5	Ammonium chloride	500 gm	450
6	Ammonium ferrous sulphate	500 gm	300
7	Ammonium hydroxide	1lit	5000
8	Ascorbic acid	100 gm	750
9	Boric acid	500 gm	500
10	Bromocresol green	5 gm	1000
11	Bromothymol blue (Indicator dye)	100gm	5000
12	Buffer solution, pH 4.0 ± 0.02	500 ml	450
13	Buffer solution, pH 9.2 ± 0.02	500 ml	450
14	Calcium carbonate ($CaCO_3$)	500 gm	250
15	Calcium chloride	500 gm	350
16	Calcium oxide (CaO)	500 gm	450
17	Calcium sulfate	500 gm	400
18	Carbon tetra chloride	1 lit	15000
19	Chloroform	2.5 lit	1500
20	Citric acid	500 gm	450
21	Cobaltous sulphate	500gm	3000
22	Copper sulphate ($CuSO_4$, $5H_2O$)	500 gm	1000
23	Dichloromethane	1 lit	1000
24	Di-potassium hydrogen phosphate	500 gm	450
25	Disodium hydrogen ortho phosphate (Na_2HPO_4. $2H_2O$)	500 gm	450
26	EDTA (Di sodium salt)	500 gm	900
27	Fehling's solution – A	500ml	500

28	Fehling's solution – B	500 ml	650
29	Ferric chloride	500 gm	450
30	Ferrous sulfide	1 kg	450
31	Ferrous sulphate	500gm	450
32	Formaldehyde	500ml	450
33	Glycerol	500 ml	600
34	Hydrochloric acid (HCl)	2.5 lit	900
35	Hydrogen peroxide (H_2O_2)	500 ml	350
36	Jack bean meal	500 gm	9000
37	Labolene	5 lit	1500
38	Magnesium oxide	500 gm	800
39	Magnesium sulfate ($MgSO_4.7\ H_2O$)	500 gm	250
40	Manganese sulphate	500 gm	250
41	Methanol	2.5 lit	600
42	Methyl orange	25 gm	250
43	Methylene blue indicator	25 gm	350
44	Nitric acid	2.5 lit	750
45	Ortho-phosphoric acid	500 ml	1250
46	Petroleum ether (40-60)	2.5 lit	450
47	pH strips (1-14)	One box	3000
48	Phenol	500 gm	700
49	Potassium dihydrogen orthophosphate (KH_2PO_4)	500 gm	500
50	Potassium iodide	250 gm	1950
51	Silica (Coarse)	500gm	450
52	Silver nitrate	25 gm	3000
53	Sodium thiosulfate pentahydrate	500 gm	250
54	Sodium carbonate (Anhydrous)	500 gm	250
55	Sodium chloride (NaCl)	500 gm	200
56	Sodium dihydrogen ortho- phosphate	500 gm	450
57	Sodium hydroxide	5 kg	1500
58	Sodium hydroxide (NaOH)	500 gm	200
59	Sucrose	500 gm	250
60	Sulphuric acid	2.5 lit	1250
61	Sulphuric acid (N/10 H_2SO_4)	1 box	1450
62	Urea	500 gm	500
63	White grease	50 g	200
64	Zinc chloride	500gm	475
65	Zinc sulphate ($ZnSO_4.7H_2O$)	500 gm	450
66	Standard solutions	AAS	50000
67.	Misc. chemicals		90,000
Approximate total cost of chemicals (NPR)			**19 LAKH**

5. FEED TESTING LABORATORY LAYOUT PLAN-COMPONENT

5.1 Office (500 sq. fts.): Lab in-charge and one assistant will occupy the office. Office should have facility of separate restroom.

5.2 Display room (450 sq. fts.):

Displaying of different feed ingredients used in feed and feed supplements for visitors from different places.

5.3 Feed processing lab (400 sq. fts.): In this room one laboratory grinder should be provided. Covered racks with partition should be provided for storing samples. It should contain chamber for digestion and ashing facilities. A room for NIR should be attached in this lab.

5.4 Mineral processing lab (450 sq. fts.): There should be proper ventilation in this room, as mainly powdery materials are handled. Mineral analysis lab should have AAS and ion analyzer facilities. It should also have separate facilities for hot air oven and muffle furnace.

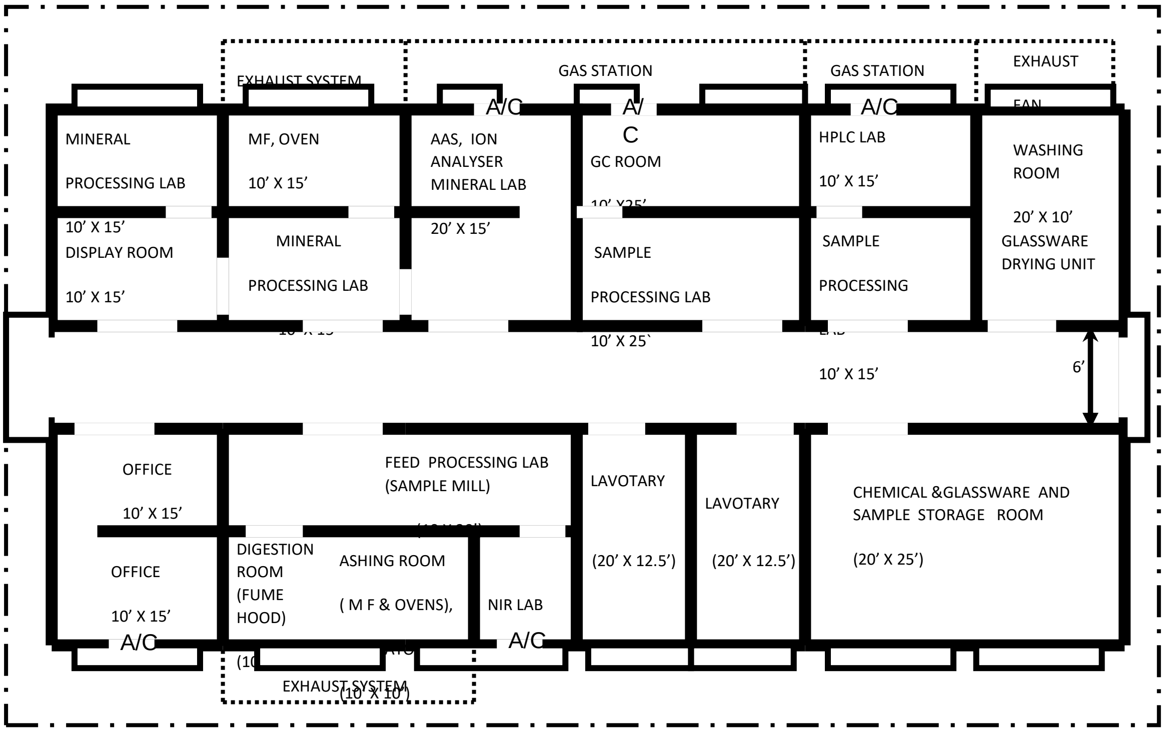
5.5 GC lab (800 sq. fts.): GC lab should have sample processing room with full ventilated facilities.

5.6 HPLC lab (900 sq. fts.): HPLC lab should have sample processing room for processing of aflatoxin, pesticide residues and other samples.

5.7 Chemical and glass ware store room (1000 sq. fts.): A store room is required for storing chemicals, glassware and other materials required for analytical work. This room should contain sufficient number of almirahs with doors fitted with glass pans so that everything can be visible.

5.8 Washing and drying room (450 sq. fts.): Glassware and plastic ware should be washed and dried here.

6. LAY OUT OF REFERENCE LABORATORY



TOTAL AREA REQUIRED FOR FEED TESTING LABORATORY – 10000 Sqfts. (1000` x 50`)

Civil work approx. cost NPR 5,00,00,000

7. GENERAL PRECAUTIONS

7.1.1 Laboratory should have efficient ventilation and exhaust fan and it should be neat and clean.

7.1.2 Reagent and chemicals should be kept in the properly labeled bottles on the shelf and these should be kept in a systematic way giving a very good look to the visitor.

7.1.3 Near the glassware washing sink, chromic acid solution should be kept in one litre capacity cylinder. Pipettes after using should be kept in this chromic acid solution at least for overnight and then should be washed.

7.1.4 Every day used glassware should be washed using any detergent powder and then rinsed with glass distilled water and these should be kept in an oven for overnight at 100^{o}C. Next day remove the glassware and transfer to a wooden almirah specified for it.

7.1.5 Freshly procured chemicals should be arranged in an alphabetical order in the steel almirah and these should be entered in the subsidiary register of respective laboratory.

7.1.6 Systematic breakage record register should be maintained, where each worker should mention the item broken and sign. This may help the worker to be more careful in future while using glassware.

7.1.7 Workers should put on white laboratory coats, while analyzing any materials in the laboratory. While using commercial acids, it would be advisable to use acid-proof hand-gloves from the safety point of view.

7.1.8 While working in Kjeldahl digestion room, every worker should use fume protecting face mask.

7.1.9 Distilled water containing bottle should always be corked to prevent it from the contamination of atmosphere ammonia. Distilled water used in nitrogen or ammonia estimation work should be free from ammonia and it should be checked regularly.

7.1.10 Worker should remember by heart that water should never be added in the acid. Always acid is added in the water. The beaker of 2 litres capacity flask should be surrounded by cold water and kept in the sink, then the job of adding acid in the water should be started.

7.1.11 During summer season, ammonia bottle should be opened after keeping it in the ice for two hours; otherwise there may be changes of injury to the worker.

7.1.12 Analytical balance and plate form should always be cleaned by using camel hair brush, before starting the job of weighing. Adjustment of balance should be checked before starting the weighing.

7.1.13 Every instrument should have log book. The workers try to record the timings of use of instrument in the log book and sign.

7.1.14 Worker should be honest and sincere while recording the final results of analysis. Every sample should be analyzed in duplicate and final results should be in range with ± 0.5 – 0.8 percent error.

7.1.15 Worker should never be allowed to smoke in the laboratory because there are chances of acting fire due to inflammable chemicals.

7.1.16 Fire extinguishing equipment should always be present in the laboratory, so as to take care of the accidental firing.

7.1.17 Filter paper after use should be thrown away in the waste-paper-basket. Floor of the laboratory should be neat and clean. Working table should also be cleaned daily.

8. LABORATORY SAFETY TECHNIQUE

2 8.1 Safe handling of acids:

Use effective acid-resistant fume removal device whenever heating acids or performing reactions, which liberate acid fumes. In diluting, always add acid to water unless otherwise directed in method. Keep acids off skin and protect eyes from spattering. If acids are spilled on skin, wash immediately with large amounts of water.

8.1.1 ***Acetic acid and acetic anhydride:***

React vigorously or explosively with CrO_3 and other strong oxidizers. Wear face shield and heavy rubber gloves when using.

8.1.2 ***Chromic and per-chromic acids:***

Can react explosively with acetic anhydride, acetic acid, ethyl acetate, isoamyl alcohol, and benzaldehyde. Less hazardous with ethylene glycol, glycerol and methanol. Conduct reactions behind safety barrier. Wear face shield and heavy rubber gloves.

8.1.3 ***Nitric acid:***

Reacts vigorously and explosively with aniline, H_2S, flammable solvents, hydrazine and metal powders (especially Zn, Al and Mg). Gaseous nitrogen oxides from HNO_3 can cause severe lung damage. Copious fumes are evolved when concentrated HNO_3 and concentrated HCL are mixed. Avoid premixing. Use effective fume removal device when fumes are generated. Handle with disposable polyvinyl chloride, not rubber, gloves.

8.1.4 ***Oxalic acid:***

Forms explosive compound with Ag and Hg. Oxalates are toxic. Avoid skin contact and ingestion.

8.1.5 ***Perchloric acid:***

Contact with oxidizable or combustible materials or with dehydrating or reducing agents may result in fire or explosion. Persons using this acid should thoroughly familiar with its hazards. Safety practices should include the following:

8.2 Remove spilled $HClO_4$ by immediate and through washing with large amounts of water.

8.2.1 Hoods, ducts and other devices for removing $HClO_4$ vapours should be made of chemically inert materials and so designed that they can be thoroughly washed with water. Exhaust systems should discharge in safe location and fan should be accessible for cleaning.

8.2.2 Avoid use of organic chemicals in hoods or other fume removal devices used for $HClO_4$ digestions.

8.2.3 Use goggles, barrier shields and other devices as necessary for personal protection; use polyvinyl chloride, not rubber, gloves.

8.2.4 In wet combustions with $HClO_4$, treat sample first with HNO_3 to destroy easily oxidizable organic matter unless otherwise specified. Do not evaporate to dryness.

8.2.5 Contact of $HClO_4$ solution with strong dehydrating agents such as P_2O_5 or concentrated H_2SO_4 may result in the formation of anhydrous $HClO_4$, which reacts explosively with organic matter and with reducing agents. Exercise special care in performing analyses requiring use of $HClO_4$ with such agents. Extremely sensitive to shock and heat when concentration is 72%.

8.3 ***Sulphuric acid:***

Always add H_2SO_4 to H_2O. Wear face shield and heavy rubber gloves to protect against splashes.

8.4 Safe handling of alkalis:

Alkalis can burn skin, eyes, and respiratory tract severely. Wear heavy rubber gloves and face shield to protect against concentrated alkali liquids. Use effective fume removal device or gas mask to protect respiratory tract against alkali dusts and vapours.

8.5 ***Ammonia:***

Extremely caustic liquid and gas. Wear skin, eye, and respiratory protection when handling in anhydrous or gaseous state. NH_3 vapors are flammable. React vigorously with strong oxidizing agents, halogens, and strong acids.

8.6 ***Ammonium hydroxide:***

Caustic liquid. Forms explosive compounds with many heavy metals such as Ag, Pb, Zn and their salts, especially halide salts.

8.7 ***Sodium and potassium hydroxides:***

Extremely caustic. Can cause severe burns. Protect skin and eyes when working with these alkalis as solids or concentrated solutions. Add pellets to H_2O, not vice versa.

8.8 Safe handling of organic solvents:

8.9 *Flammable solvents:*

Do not let vapors concentrate to flammable level in work area. It is nearly impossible to eliminate all chance of sparks from static electricity even if electric equipment is grounded. Use effective fume removal device to remove these vapors when released.

8.10 *Toxic solvents:*

Vapors from some volatile solvents are highly toxic. Several of these solvents are readily absorbed through skin. Use effective fume removal device to remove vapors of these solvents as they are liberated.

8.11 Safe handling of special chemical hazards:

8.11.1 Acetonitrile:

Toxic. Avoid contact with skin and eyes. Use effective fume removal device.

8.11.2 *Benzene:*

Toxic. Highly flammable. Avoid contact with skin. Do not breathe vapors. Use effective fume removal device. Decomposes violently in presence of strong oxidizing agents. Reacts violently with Cl_2. Considered to be carcinogenic.

8.11.3 *Acetone:*

Highly flammable. Forms explosive peroxides with oxidizing agents. Use effective fume removal device.

8.11.4 *Bromine and chlorine:*

Hazardous with NH_3, H_2, petroleum gases, turpentine, benzene and metal powders. extremely corrosive. Use effective fume removal device. Protect skin against exposure.

8.11.5 *Carbon tetrachloride:*

Reacts violently with alkali metals. Toxic. Fumes may decompose to phosgene when heated strongly. Use effective fume removal device.

8.11.6 *Chloroform:*

Can be harmful if inhaled. Forms phosgene when heated to decomposition. Use effective fume removal device. Can react explosively with Al, Li, Mg, Na, K, N_2O_4 and NaOH plus methanol.

8.11.7 *Cyclo-hexane:*

Highly flammable. Use effective fume removal device. Can react vigorously with strong oxidizing agents.

8.11.8 *Diethyl ether:*

Store protected from light. Extremely flammable. Unstable peroxides can form upon long standing or exposure to sunlight in bottles. Can react explosively when in contact with Cl_2, O_3, $LiAlH_4$ or strong oxidizing agents. Use effective fume removal device. Avoid static electricity

8.11.9 *Ethanol:*

Flammable. Use effective fume removal device when heating or evaporating.

8.11.10 *Hydrogen sulfides:*

Hazardous with oxidizing gases, fuming HNO_3 and Na_2O_2. Forms explosive mixtures with air. Toxic. Use effective fume removal device.

8.11.11 *Hexane:*

Highly flammable. Use effective fume removal device.

8.11.12 *Methanol:*

Flammable. Toxic. Avoid contact with eyes. Avoid breathing vapors. Use effective fume removal device. Can react vigorously with NaOH plus $CHCl_3$, and KOH plus $CHCl_3$ or $HClO_4$.

8.11.13 ***Oxidizers:***

(Perchlorates, peroxides, permanganates, persulfates, perborates, nitrates, chlorates, chlorites, bromates, iodates, concentrated H_2SO_4, Concentrated HNO_3, CrO_3.)

Can react violently with most metal powders, NH_3, and ammonium salts, P, many finely divided organic compounds, flammable liquids, acids and S. Use exactly as specified in method. Handle in effective fume removal device from behind explosion-resistant barrier. Use face shield,

8.11.14 ***Peroxides:***

Hydrogen peroxide –30% strength is hazardous; can cause severe burns. Drying H_2O_2 on organic material such as paper or cloth can lead to spontaneous combustion. Cu, Fe, Cr, other metals and their salts cause rapid catalytic decomposition of H_2O_2. Hazardous with flammable liquids, aniline, and nitrobenzene. Since it slowly decomposes with evolution of O_2, provide stored H_2O_2 with vent caps. Wear gloves and eye protection when handling.

Ether peroxides -These peroxides form in diethyl ether, dioxane and other ethers during storage. They are explosive and must be destroyed chemically before distillation or evaporation. Exposure to light influences peroxide formation in ethers. Filtration through activated alumina is reported to be effective in removing peroxides. Store over sodium ribbon to retard peroxide formation.

8.11.15 ***Petroleum ether:***

Extremely flammable. Use effective fume removal device. Avoid static electricity.

8.11.16 ***Silver nitrate:***

Powerful oxidizing agent; strongly corrosive. Dust or solid form is hazardous to eyes. Handle as noted for oxidizers.

8.11.17 ***Permanganate:***

Moderately toxic. Readily soluble in water. Strong oxidizing agent. May form explosive mixture with H_2SO_4 or $HClO_4$. When using with strong acids to destroy organic matter, perform reaction behind safety barrier.

8.1.18 Mycotoxins:

UV light is dangerous to the eyes. Protective goggles must be worn.

Mycotoxins should be handled as very toxic substances. Perform manipulations under hood whenever possible. All mycotoxins are potential health hazard in one way or the other, Aflatoxin B_1 is a highly carcinogenic substance and shall therefore be handled very carefully. Do not transfer dry aflatoxin for weighing or other purposes unless facilities (e.g., glove box) are available to prevent dissemination of aflatoxin to surroundings due to electrostatic charge on particles. Rinse all glassware exposed to aflatoxin carefully with chloroform, then with solution of NaOCl bleach (5% v/v solution in water) and then wash thoroughly. Swab accidental spills of aflatoxins with the solution of NaOCl bleach.

9. MAINTENANCE OF REGISTERS

Following registers should be maintained in Feed Testing Laboratory:

Sr. No.	**Register**
1	General register
2	Stock register for consumable articles
3	Stock register for capital articles
4	Glassware register
5	Chemical register
6	Annual maintenance contract register
7	Glassware breakage register
8	Chemical uses register
9	Proximate analysis register
10	Mineral analysis register
11	Aflatoxin analysis register
12	Pesticide residues analysis register
13	Methane emission estimation register
14	Visitors / training record registers

10. FIRST AID SERVICES

10.1 Following medicinal items should be ready in laboratory.
10.1.1 Soframycin skin cream
10.1.2 Providone iodine solution
10.1.3 Tincture iodine solution
10.1.4 Absorbent cotton
10.1.5 Band aid
10.1.6 Eye / ear drops
10.1.7 Pain relief spray
10.1.8 Burn relief spray
10.1.9 Antiseptic spray bandage
10.1.10 Savlon liquid
10.1.11 Cotton gauge roll
10.1.12 Neomycin powder

Chapter 7
Establishment of a Bypass Protein Plant

7. INTRODUCTION

7.1. Protein forms one of the most significant constituents of the ruminants' ration. It is, therefore, of paramount importance to ensure that this constituent is utilized with high efficiency.

7.2. Protein is usually the first limiting nutrient for cattle fed low quality forages. Protein is necessary for rumen microbes to digest fibre and other feedstuff components.

7.3. All ruminants, including dairy animals, derive their protein requirement from two sources. One is rumen undegraded feed protein that gets enzymatically digested in the abomasum and small intestine and another source of protein is rumen microbes.

7.4. If dietary nitrogen intake of ruminant animals is manipulated in such a way, so as to maximize amino acids availability from rumen microbial output and undegraded dietary protein, then the growth and milk production in animals can be maximized with marginal increase in feed cost.

7.5. Protein meals, particularly rumen escape proteins, play a very important role as excellent protein supplement, in livestock feeding. When these meals are fed as such to ruminants, about 70 per cent of the protein is broken down to ammonia by the rumen microbes in the rumen and a significant portion is converted to urea in liver and excreted in the form of urea through urine.

7.6. However, if these meals are subjected to suitable chemical treatment – termed as **"bypass protein technology"**, then their efficiency of utilization can be significantly improved.

7.7. The bypass protein supplement provides essential amino acids, to be available for absorption at the small intestine. When chemically treated protein meals replace untreated one, then due to less degradability of the protein, excessive loss of both nitrogen and energy could be avoided, resulting in an increased energy and nitrogen balance, leading to increase in milk yield and milk constituents.

8. PRODUCTION PROCESS FOR BYPASS PROTEIN SUPPLEMENT

2.1 Load the protein meal under the treatment on to the hopper and transfer via auger to the vibro feeder. Then grind it to 2-3 mm particle size by the hammer mill and transfer to the fountain mixer via auger.

2.2 When half (50%) of protein meal is transferred to the mixer, operate the formaldehyde pump to discharge liquid formaldehyde having viscosity and specific gravity similar to water.

2.3 Mix protein meal with desired level of formaldehyde (37-40% w/v) for 15-30 minutes.

2.4 Simultaneously, the remaining half of protein meal continues to pour in the mixer, to avoid formation of formaldehyde lumps at the bottom of the mixer.

2.5 After complete receiving of protein meal in the mixer and desired quantity of formaldehyde, allow the protein meal in the mixer for homogeneous mixing for another 15 minutes.

2.6 Discharge the treated protein meal to air tight silo and store it for a period of 8 days.

2.7 After 2 days of incubation period, treated meal can be transferred to HDPE laminated bags, for storage up to 6 days. Treated protein meal(s) can be fed either directly as top feed or can be incorporated in compounded cattle feed @ 25 per cent.

9. LEVEL OF FORMALDEHYDE FOR TREATMENT OF VARIOUS PROTEIN MEALS

Sr. No.	Protein meals	Level of HCHO (% of CP)
1	Rapeseed meal	0.5
2	Sunflower meal	0.5
3	Soybean meal	0.5
4	Groundnut meal	0.6
5	Guar meal	0.6
6	Cottonseed meal	0.7

10. HOW TO FEED BYPASS PROTEIN SUPPLEMENT AND ECONOMIC BENEFITS

4.1 Treated protein meals can be either fed directly to animals as top feed @ one kg per animal per day or else, treated meals can be incorporated in cattle feed @ 25 per cent and this feed (bypass protein feed) can be fed @ 4-5 kg per animal per day, depending upon the level of milk production.

4.2 As cost of treatment of meals ranges from NPR 4 to 4.5 per kg, including profit margins at different levels, in all a farmer is to spend NPR 2.5 to 3.00 extra if he feeds daily either one kg bypass protein supplement or 4-5 kg bypass protein feed, containing 25% treated protein meals. SNF content of milk can also be increased with the bypass protein supplement.

5. ECONOMICS OF FEEDING BYPASS PROTEIN FEED AT FARMERS' LEVEL

5.1 Research study revealed that, on feeding bypass protein feed, average increase in net daily income was NPR 10, 12 and 14 in local cows, crossbreds and buffaloes, respectively. It is important to remember that for maximum economic returns, over feeding should be avoided.

5.2 In case of crossbreds, there was maximum increase in milk production, however, net daily gain was lower as the level of feeding was higher than the recommended level.

6. SAFETY ASPECTS

6.1 As bypass protein supplement is produced in a specially designed airtight plant, there is no risk to workers operating bypass protein plant.

6.2 Moreover, workers on the plant are advised to wear gloves, masks and safety glasses.

6.3 Meter is provided at the plant, which produces beep-beep like sound if there is any leakage in the plant, as and when level of chemical increases beyond 2 ppm.

6.4 Chemical used for treatment of protein meals is at very-very low levels and it poses no health risk to animals and the consumers. It is not excreted in milk and no residues of chemical are found in meat of beef animals, as evidenced by several scientific studies, world over.

6.5 Even use of treated meals has been declared to be safe by the US-FDA, in the ration of beef and milk producing animals.

7. ADVANTAGES OF FEEDING BYPASS PROTEIN SUPPLEMENT

7.1 Cheaper source of protein for animals

7.2 Increases availability of essential amino acids.

7.3 Improvement in milk production.

7.4 Easier to meet the requirement of high yielding animals.
7.5 Improvement in fat and SNF per cent.
7.6 Helps in increasing net daily income.
7.7 Better growth in young animals.
7.8 Improved reproduction efficiency.
7.9 Better resistance against diseases.
7.10 Helps to control salmonella and reduce mould growth when used with cattle feed.

8. COST ESTIMATE OF BYPASS PROTEIN PLANT - CAPACITY 20 MTPD

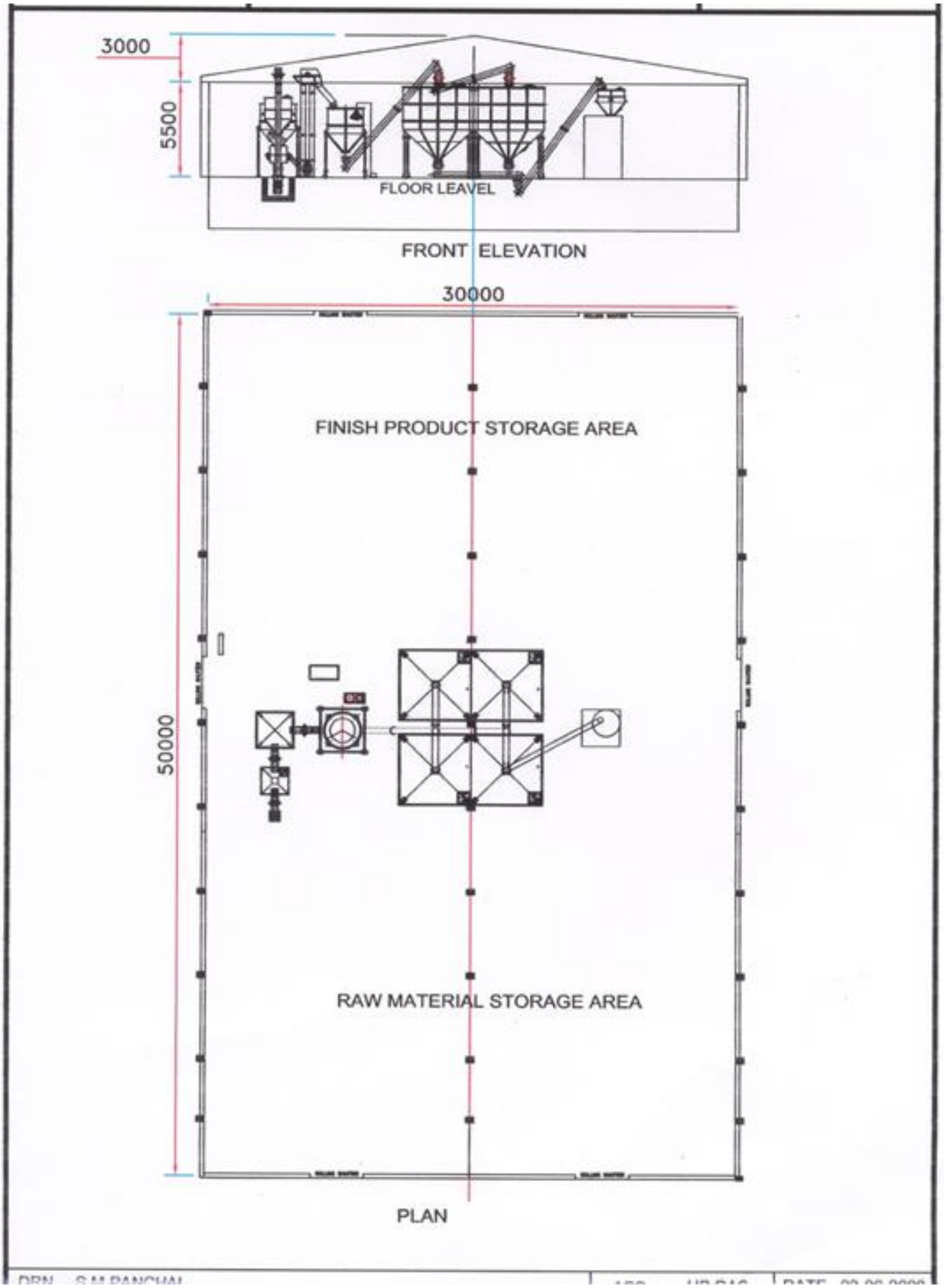
Sl. No.	EQUIPMENT	QTY.	UNIT	HP
1	Intake dumping hopper with magnetic grill, size 600 mm x 600 mm x 400 mm	1	NO	
2	Intake Elevator, capacity – 10 TPH	1	NO	3
3	Holding Bin above hammer mill, capacity – 1 MT	1	NO	
4	Manually Operated Chain gate	1	NO	
5	Rotary Feeder for Hammer mill, Capacity- 3 MT / HR	1	NO	1.5
6	Hammer Mill (Full Circle Type), Cap. 3 MT / HR.	1	NO	30
7	Powder Elevator –capacity - 5 TPH	1	NO	3
8	Holding Bin for Fountain Mixer – 3 MT	1	NO	
9	Powder Elevator for mixer–capacity – 5 TPH	1	NO	3
10	Fountain Type Airtight Mixer, Cap. - 3 MT / Batch	1	SET	3
11	Formalin Metering System, Cap. 0-500Ltrs./hr	1	SET	1
12	Air tight inclined screw conveyor - 5 TPH	1	NO.	7.5
13	Inclined intermediate conveyor, capacity - 5 TPH	1	NO	5
14	Distribution Conveyor capacity – 5 TPH	1	NO	10
15	Airtight Silo, Capacity- . 15 MT	2	NO	
16	Discharge conveyor; Cap –10 TPH	2	NOS	10
17	Common discharge conveyor, Cap. 10 TPH	1	NO	5
18	Inclined discharge conveyor for bagging bin.Cap.10 TPH	1	NO	7.5
19	Bagging Bin, capacity – 1 MT	1	NO	
20	Bagging Off Weigher, capacity- 5 TPH	1	NO	2
21	Stitching Machine (Portable)	1	NO	
22	Check Scale 100 KG.	1	NO	
23	Air Compressor, Cap. 9 Cu. M./Hr,12 kg/sq.cm,160 L	1	NO	5

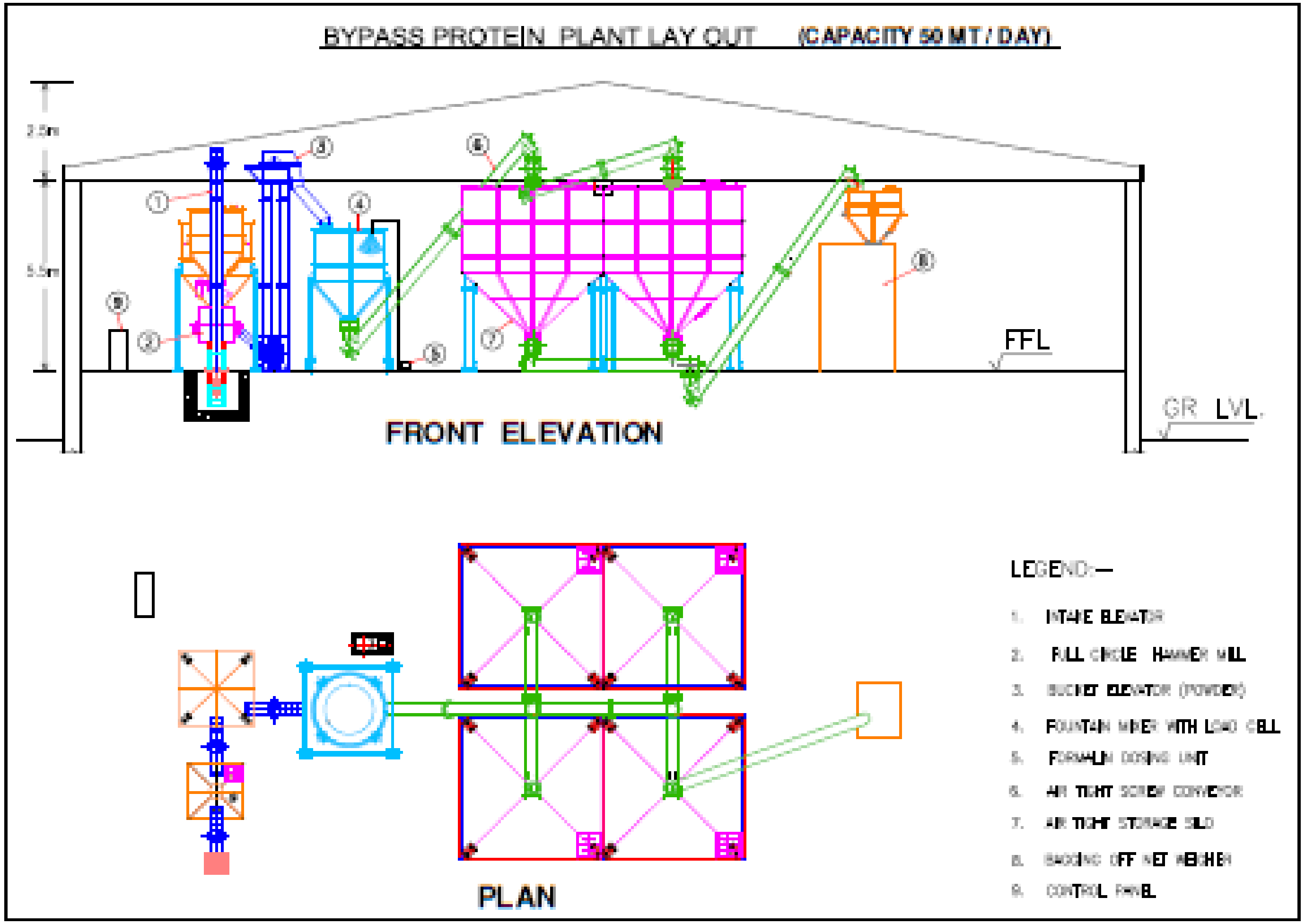
24	Motor Control Centre cum Mimic Panel	1	NO	
25	Aspiration System for bagging stations & formalin dosing system	1	SET	5
26	Fire Extinguisher	1	SET	
27	Electricals	1	LOT	
28	Spares	1	SET	
29	Structural Material	5	MT	
30.	**Approx. cost NPR 200 lakh for 20 MTPD plant**			

9. TENTATIVE COST OF TREATMENT

Sr.No.	DETAILS	**COST (NPR/ MT)**
1	Cost of chemicals	150.00
2	Labour and supervision cost (4 labour/shift; @ NPR 500 / Head: 1 Shift), Supervisor-1/shift. (NPR 40,000 p.m. / head)	100.00 35.00
3	Electricity 53 KWH (NPR 7 per unit)	150.00
4	Depreciation (20% of 96 lakh) (Storage silo-2 nos.)	170.00
5	Interest (~10%/year on NPR 200 lakh)	120.00
6	HDPE Bags, (NPR 20.00/bag for 50 kg packing) 20 bags	400.00
Treatment cost of protein meal (Approx.)		**1125.00**

10. LAY OUT OF BYPASS PROTEIN PLANT (20 MTPD)




BYPASS PROTEIN PLANT LAY OUT (CAPACITY 50 MT / DAY)
2.5m
5.5m
FFL
GR. LVL.
FRONT ELEVATION
PLAN
LEGEND:—
1. INTAKE ELEVATOR
2. FULL CIRCLE HAMMER MILL
3. BUCKET ELEVATOR (POWDER)
4. FOUNTAIN MIXER WITH LOAD CELL
5. FORMALIN DOSING UNIT
6. AIR TIGHT SCREW CONVEYOR
7. AIR TIGHT STORAGE SILO
8. BAGGING OFF NET WEIGHER
9. CONTROL PANEL

11. INSTRUCTIONS AND SAFETY GUIDELINES FOR BYPASS PROTEIN PLANT

11.1 Requirement

11.1.1 Face shield or goggles to protect the face and eye
11.1.2 Hand gloves
11.1.3 Face mask for formaldehyde
11.1.4 Gumboots and impervious apron
11.1.5 Good quality barrier cream for skin
11.1.6 Emergency face/eye washer and shower

11.2 Protective clothing and equipment

11.2.1 Wear a laboratory coat and gloves when handling formaldehyde.

11.2.2 Face shield or goggles to protect the face and eyes from splashes should be worn when mixing or handling formaldehyde.

11.2.3 Gumboots and an impervious apron should be worn when handling tanks or drums of formaldehyde.

11.2.4 Apply a good quality barrier cream on hands and forearms to prevent dermatitis and general skin irritation.

11.3 Using formaldehyde

11.3.1.1 Keep the emergency face/ eye wash and shower clear from obstruction.

11.3.1.2 Wash your hands, arms, face and neck thoroughly after work and before eating.

11.3.1.3 Do not leave any containers of formalin in the sun or exposed to high temperature.

11.3.1.4 To prevent spillage always move large tanks and drums with the lids firmly on. Never try to move these items by yourself.

11.3.1.5 Always handle formaldehyde near a reliable supply of unlimited water to dilute spills etc.

11.3.1.6 Maintain a high standard of laboratory housekeeping.

11.3.1.7 Only use specimen containers with airtight lids and proper seals. Use bubble wrap under lids of large tanks to improve the seal.

11.3.1.8 Formaldehyde should be stored in a cool, well-ventilated location out of direct sun-light and away from other sources of heat and ignition.

Chapter 8
Calf Rearing Program for Female Cow and Buffalo Calves

1. INTRODUCTION

1.1 Todays' calves are tomorrows' cows. During the field visit, growing calves were found to be suffering from various deficiencies with stunted growth and rough skin coat. As a result, age at first calving is 4-5 years, inter-calving interval is longer and lactation length is shorter. It is proposed that in the project areas calf rearing program will be launched, wherein, pregnant animals during the last two months of lactation will be fed special pregnancy feed.

1.2 Due to inadequate nutrition and poor growth rate in early life, animals are not able to produce milk commensurate with their genetic potential, even if they are fed optimally. Growth phase of the animals is confined to the first two years of life. It is, therefore, important that the calf is provided all essential nutrients right from its foetal phase. Calves thus born shall be healthy and fed with calf starter and calf growth meal. This will be helpful in reducing age at first calving significantly and increasing lactation length.

1.3 In view of this, it is envisaged under the calf rearing program that the milk producers will be advised to feed optimally to cows and buffaloes in the advanced stage of pregnancy. Subsequently, thus healthy born calves will be fed on scientific lines so that they grow at desired rate and attain early maturity. In this manner, healthy heifers after calving would produce milk in accordance with their genetic potential, under optimum conditions of feeding and management. The program will be run for demonstration purpose in the limited project areas, on the graded and cross bred animals.

2. OBJECTIVES OF THE CALF REARING PROGRAM

2.1 Providing essential nutrients during advanced stage of pregnancy, to ensure calves born are healthy.

2.2 Rearing female cow and buffalo calves to reduce mortality rate by following scientific feeding & management practices.

2.3 To reduce age at first calving by improving daily growth rate and achieving early maturity weight by feeding calf starter & calf growth meal.

2.4 To improve life time productivity & productive life of animals, by rearing calves at farmer's doorstep which could be more disease resistant & would have better feed conversion efficiency.

3. GOLDEN RULES FOR REARING HEALTHY FEMALE CALVES

3.1 Start feeding desired nutrients from the advanced stage of pregnancy (last 60 days) to ensure that the calf born is healthy.

3.2 Provide adequate quantity of colostrum within 1 to 2 hours of birth.

3.3 Take preventative action for navel and respiratory infections.

3.4 House calves in a clean, dry, well ventilated housing with 1.2 to 1.5 square metres of space per calf.

4. PRODUCTION OF FEEDS FOR DIFFERENT CATEGORIES OF ANIMALS UNDER THE PROGRAM

4.1 Feed for advanced pregnant animals i.e. Pregnancy Feed

4.1.1 Special type of feed having higher vitamins E & A, D_3, anionic salts, chelated minerals, quality protein meals, bypass fat & higher level of grains, will be produced at one location having cattle feed production facility & supplied to identified milk producers at 50% subsidy.

4.1.2 Pregnancy feed will be provided to the participating agency under the scheme, as per the formulation & specifications as mentioned at 4.1.2.1 and 4.1.2.2.

4.1.2.1 Ingredient composition of pregnancy feed

Sl. No.	Name of the raw material	Quantity (kg/100 kg)
1.	Maize grain	35
2.	Rice polish fine	11
3.	Treated rapeseed meal	17
4.	Decorticated cottonseed meal	17
5.	Molasses	10
6.	Sugar beet pulp / wheat bran	5
7.	Magnesium chloride	0.5
8.	Coated ammonium chloride (15% fat)	1.5
9.	Calcium chloride	1.5
10.	Copper glycinate	50 g
11.	Zinc glycinate	200 g
12.	Manganese glycinate	100 g
13.	Chromium chelate	15 g
14.	Vitamin-AD_3 (Vit-A: 10 lakh IU/g & Vit-D_3: 2 lakh IU/g)	20 g
15.	Vitamin-E (coated)	80 g
16.	Lacto-vanilla coconut flavor	15 g
17.	Bypass fat	1.0
18.	Common salt	0.20
Total		**100**

4.1.3 Daily 3 kg feed will be recommended for feeding during the last 2 months of pregnancy.

4.1.4 This would help in reducing metabolic disorders & calf born will be healthy.

4.1.2.2 Specifications for pregnancy feed (on DM basis)

Sl. No.	Characteristic	Requirement
1.	Moisture (%), max.	11.0
2.	Crude protein (%), min.	24.0
3.	Crude fat (%), min.	4.0
4.	Crude fibre (%), max.	8.0
5.	Acid insoluble ash (%), max.	2.5
6.	Calcium (%), min.	0.4

7.	Phosphorus (%), min.	0.5
8.	Vitamin-A (min.)	15,000 IU/kg
9.	Vitamin D_3 (min.)	3,000 IU/kg
10.	Vitamin-E (min.)	400 IU/kg
11.	Aflatoxin B_1 (max.)	20 ppb

4.2 Calf Starter

4.2.1 Special type of calf starter in 3-4 mm pellets incorporating certain feed additives, which would help in improving daily growth rate & rumen development will be produced at the same location and supplied to the identified milk producers at 50% subsidy.

4.2.2 Calf starter will be provided to the participating agency under the scheme, as per the formulation & specifications as mentioned at 4.2.2.1 and 4.2.2.2.

4.2.3 Calf starter would be fed from 3rd week onwards up to 26th week of age.

4.2.4 This would help in early development of rumen, faster growth rate & early maturity weight.

4.2.2.1 Ingredient composition of calf starter (From 1-26 weeks of age)

Sl. No.	Ingredient	Quantity (kg/100kg)
1.	Maize grain	28
2.	Soybean meal	33
3.	Rice polish fine	8
4.	Sugar beet pulp/wheat bran	15
5.	Bypass fat	2
6.	Mineral mixture	2
7.	Calcite powder	0.8
8.	Common salt	1.0
9.	Molasses	9.0
10.	Mycotoxin binder	0.5
11.	Sodium butyrate (Coated)	0.5
12.	Vitamin AD_3 (Coated) (Vit-A: 1million IU/g & Vit-D_3: 0.2 million IU/g)	20 g
13.	Vitamin-E (Coated)	25 g
14.	Lacto-vanilla Coconut flavour	20 g
15.	Butylated hydroxy toluene (BHT)	5 g
16.	Calcium propionate	100 g
17.	Chromium chelate	10 g

Caution: Urea & other ammonium salts should not be added in the calf starter formulation

4.2.2.2 Specification for calf starter (on DM basis)

Sl.No.	Characteristic	Requirement
1.	Moisture, percent by mass, Max.	10
2.	[1]Crude protein (N x 6.25), percent by mass, Min.	23
3.	Crude fat, percent by mass, Min.	4.0
4.	Crude fibre, percent by mass, Max.	9.0

5.	Calcium (as Ca) per cent by mass, Min.	0.8
6.	Total phosphorus, per cent by mass, Min.	0.5
7.	Available phosphorus, per cent by mass, Min.	0.25
8.	Vitamin A, I.U./kg, Min.	10,000
9.	Vitamin D_3, I.U./kg, Min.	1,200
10.	Vitamin E, I.U./kg, Min.	100
11.	Aflatoxin B_1 (ppb), Max.	20
12.	Urea (%)	Nil
13.	Calcite powder (%), Max.	1.0

Note: [1]While analysing for crude protein, it should be ensured that the nitrogen has not been derived from urea or other ammonium salts.

4.3 Calf Growth Meal

4.3.1 Calf growth meal will also be produced at the same location and the feed formulation will be to the participating agency under the scheme, as per the ingredient composition & specifications as mentioned at 4.3.1.1 and 4.3.1.2.

4.3.1.1 Ingredient composition of calf growth meal (From 27-108 wk of age)

Sl. No.	Ingredient	Quantity (kg/100kg)
1.	Maize grain	28
2.	Soybean meal/De-corticated cottonseed meal	30
3.	Rice polish fine	9
4.	Sugar beet pulp/wheat bran	15
5.	Bypass fat	1.0
6.	Mineral mixture	2
7.	Calcite powder	0.5
8.	Common salt	1.0
9.	Molasses	10
10.	Mycotoxin binder	0.5
11.	Sodium butyrate (Coated)	0.5
12.	Vitamin AD_3 (Coated) (Vit-A: 10 lakh IU/g & Vit-D_3: 2 lakh IU/g)	20 g
13.	Vitamin-E (Coated)	25 g
14.	Lacto-vanilla Coconut flavour	20 g
15.	Butylated hydroxy toluene (BHT)	5 g
16.	Calcium propionate	100 g
17.	Chromium chelate	10 g
18.	De-oiled rice bran (DORB)	2.50

Caution: Urea & other ammonium salts should not be added in the calf growth meal.

4.3.1.2 Specification for calf growth meal (on DM basis)

Sl.No.	Characteristic	Requirement
1.	Moisture, percent by mass, Max.	10
2.	[1]Crude protein (N x 6.25), percent by mass, Min.	22
3.	Crude fat, percent by mass, Min.	3.0

4.	Crude fibre, percent by mass, Max.	12.0
5.	Calcium (as Ca) per cent by mass, Min.	0.8
6.	Total phosphorus, per cent by mass, Min.	0.5
7.	Available phosphorus, per cent by mass, Min.	0.25
8.	Vitamin A, I.U./kg, Min.	7,000
9.	Vitamin D_3, I.U./kg, Min.	1,200
10.	Vitamin E, I.U./kg, Min.	100
11.	Aflatoxin B_1 (ppb), Max.	20
12.	Urea (%)	Nil
13.	Calcite powder (%), Max.	1.0

Note: [1]While analysing for crude protein, it should be ensured that the nitrogen has not been derived from urea or other ammonium salts.

4.3.2 Daily 2 kg calf growth meal is required to be fed to growing calves from 27-108 weeks of age.

4.3.3 Calf growth meal would help in achieving desirable body weight at an early age and proper development of reproductive organs & mammary tissue.

5 FEEDING SCHEDULE DURING DIFFERENT STAGES OF CALF GROWTH

5.2 Calf feeding schedule (birth to 26th week of age)

Period	Colostrum/ Whole Milk (kg/day)	Calf starter (kg/day)	Good quality hay* (kg/day)	Green fodder* (kg/day)
0-2 days	1.5-2.0 colostrum	--	--	--
3-4 days	1.5-2.0 milk	--	--	--
4-14 days	1.0-1.5 milk	0.10	0.10	--
3rd week	0.5-1.0 milk	0.20	0.15	0.15
4th week	*Milk (0.5 kg) or milk*	0.25	0.20	0.25
5th week	*replacer (0.25 kg) can be*	0.40	0.30	0.50
6th week	*fed, if available with*	0.50	0.40	1.0
7th week	*progressive dairy farmers*	0.60	0.60	1.5
8th week	*& having good economic*	0.70	0.80	2.0
9th week	conditions	0.80	0.90	2.5
10th -11th wk		1.00	0.90	3.0
12th week		1.20	1.00	3.5
13th -16th wk		1.50	1.20	4.0
17th -20th wk	--	1.75	1.50	4.5
21st -26th wk	--	2.00	2.0	5.0

Note: *Requirement of hay and green fodder may vary from breed to breed & body weight of calf. Colostrum feeding is very essential during early life of calf.

5.2 Calf feeding schedule (27th -108 wk of age)

Period	Calf growth meal (kg/day)	Good quality hay* (kg/day)	Green fodder* (kg/day)	Mineral mixture (g/day)
27-40 week	2.0	2.5	10	25
41-60 week	2.0	3.5	12	30
61-90 week	2.0 (2.5**)	5.0	14	50
91-108 week	2.0 (3.0**)	6.0	16	75

Note: *Requirement of hay and green fodder may vary from breed to breed & body weight of calf.
**Feeding of calf growth meal may be adjusted based on the age and body weight.

5.3 Requirement of pregnancy feed/calf starter/calf growth meal per animal

Feed type	Quantity required (kg)	Approx. cost (NPR/kg)	Total cost (NPR) per calf
Pregnancy feed requirement for 60 days (kg) @ 3 kg/day	180	40	7,200
Calf starter requirement for 178 days (kg)	225	48	10,800
Calf growth meal requirement for 574 days (kg) @ 2 kg/day	1148	40	45,920
Total (NPR)			**63,920**

6 IMPLEMENTATION ARRANGEMENT OF CALF REARING PROGRAM

6.2.1 The project will be implemented on a modular approach. Each module will comprise of about 60 to 80 villages covering 250 female calves under one participating agency.

6.2.2 One Field Officer (FO) will be responsible for project implementation and monitoring including liaising with Nepal Livestock Board for all projects related activities.

6.2.3 One field supervisor (FS) would be identified from a village & will cover two villages and will be responsible for recording information on the female calves, in a particular format, till the completion of the program.

6.2.4 Field supervisor will ensure the feeding of specialized feeds and record body weight of calves every month.

6.2.5 After completion of six month of project implementation, farmers' awareness campaign will be organised by the field officer. Five such campaigns would be conducted during the project period.

6.3 *Step-I: Selection of advanced pregnant animals*

6.3.1 About 500 advanced pregnant crossbred cows/buffaloes (min. 7 months of pregnancy) will be identified from 80-100 villages, depending upon the availability.

6.3.2 During advanced stage, pregnancy feed will be fed to identified animals @ 3 kg per day. Pregnancy feed will be made available to milk producers at 50% subsidy.

6.3.3 A booklet with package of practices to be followed would be provided to milk producers in local language.

6.3.4 Details pertaining to pregnant cows/buffaloes, ID number, previous history like milk yield, lactation yield, date of conception, expected date of calving will be recorded.

6.4 ***Step-II: Registration of newly born calf***

6.4.1 On calving, milk producers would inform the officer concerned of the implementing agency for registration of female calf only. Out of 500 calves born, about 50% calves would be male and would be excluded from the program.

6.4.2 Registration of calf immediately after birth will be done by the identified officer.

6.4.3 Ear tagging of calves will also be done with a unique identification number.

6.4.4 Birth date & ear tag number of registered calf/calves will be entered in the booklet.

6.4.5 Pregnancy feed, calf starter, calf growth meal, mineral mixture, de-wormer drug etc. will be made available in the identified villages under the program. Calf starter will be supplied at 50% subsided rate.

6.4.6 If the heifer attains pregnancy at a desired age, an incentive will be provided to milk producers, details given below.

6.3.7 Proposed re-imbursement schedule under the program

Expected age at conception (months)	Incentive amount (NPR)
18	10,000
19	8,000
20	6,000
21	5,500
22	5,000
23	4,500
24	4,000
25	3,500
26	3,000
27	2500
More than 28 months	Nil

7 EXPECTED BENEFITS FROM THE PROGRAM

7.2.1 Age at first calving in graded buffaloes and crossbred cow calves would be reduced by 10-12 months.

7.2.2 Calf mortality would be reduced by 8-10%.

7.2.3 The heifer’s would attain maturity (225-275 kg) at the age of 18-24 months.

7.2.4 Lactation length would increase from average 250 to 300 days.

8. Cost Table: Physical & financial outlay to cover 250 female calves under calf rearing program

Sl. No.	Particular	Number	Unit price (NPR)	Year-1	Year-2	Year-3	Year-4	Total cost (NPR)
A	**Physical target**							
1	Field officer	1		1	1	1	1	1
2	Field supervisor	**40**		**40**	**40**	**40**	**40**	**40**
3	Villages	80		80	80	80	80	800
4	Number of pregnant animals covered	500		500				500
5	Number of female calves covered	250		250	250	250	250	250
B	**Financial Outlay**							
1	Laptop cum printer for field officer	1	80000	80000				80000
2	Datacard to officer (for 4 years)	1	5000	5000	5000	5000	5000	20000
B1	**Capital expenditure**			**85000**	**5000**	**5000**	**5000**	**100000**
1	Salary of field officer (for 4 years)		50000	600000	600000	600000	600000	2400000
2	Stipend to field supervisors (for 4 years)	40	5000	2400000	2400000	2400000	2400000	9600000
3	Cost of pregnancy feed (50% subsidy)		40	1800000				1800000
4	Subsidy on calf starter @ 50% subsidy		48	1350000				1350000
5	Subsidy on calf growth meal @ 50% subsidy		40		7175000			7175000
6	Insurance of calves (deworming may be included) @ NPR1000 per calf for 4 years	250	1000	250000	250000	250000	250000	1000000
7	Ear tag (20% extra)	300	15	4500				4500
8	Ear tag application charges	250	25	6250				6250
9	Calf Rearing Kit	40	5000	200000				200000
10	Stationery/ Data records (Booklet etc) - 4 years	LS	LS	25000	25000	25000	25000	75000
11	Office expenses for 4 years	LS	LS	5000	5000	5000	5000	20000
12	Communication charges for 4 years	1000/month	1000/month	24000	24000	24000	24000	96000
13	Travel expenses (4 years)		25000	300000	300000	300000	300000	1200000
13	Re-imbursement on getting pregnant at	250	10000				2500000	2500000

	desired age							
B2	**Operational expenditure**			**6964750**	**10779000**	**3604000**	**6104000**	**27426750**
1	Farmer meeting for 4 years	40	2500	100000	100000	100000	100000	400000
2	Promotional materials	40	1500	60000	60000	60000	60000	240000
3	Awareness campaign on calf rearing	250	500	250000	250000	250000	250000	1000000
4	Training of field supervisor	40	10000	960000				960000
5	Training of field officer	2	20000	40000				40000
B3	**Training & Extension expenditure**			**1410000**	**410000**			**2640000**
Total revenue expenses (NPR) (B2+B3)				**8374750**	**11189000**			**30066750**
Total NPR (B1+B2+B3)				**8459750**	**11194000**	**3609000**	**6109000**	**30166750**
Total NPR in Lakh (SAY)								**302**
Note: 1250 female calves will be covered under scheme and total 5 modules, one module of 250 female calves will be covered under the program. Cost break up of one module for rearing 250 female calves is attached. Total cost of 5 modules will be about NPR 1510 lakh.								

Chapter 9
Green Fodder Production Enhancement and its Conservation

1. Introduction

1.1 Adequate availability of feed and fodder to livestock is vital for increasing their productivity and also to sustaining ongoing genetic improvement initiatives. Optimum and efficient utilization of fodder resources holds key for successful commercial livestock production.

1.2 Fodder is an important component of animal ration and its adequate availability is essential to exploit the genetic potential of the livestock. Despite that green fodder is an economic source of macro and micro nutrients, its availability is a limiting factor for the growth of dairy industry. The availability of green fodder is constrained due to followings:

1.2.1 Most of the milk producers are landless, marginal and small farmers and do not have sufficient land for fodder production.

1.2.2 Farmers are not adopting latest technologies like use of quality fodder seeds, leading low productivity of green fodder.

1.2.3 To meet the growing demand of humans for food, fiber and shelter, fodder production was never given due attention.

1.2.4 The status of permanent pasture and common grazing lands are deteriorating due to huge grazing pressure, lack of adequate institutional arrangement and encroachment of land etc.

1.2.5 Poor awareness of the farmers about various technologies to improve the availability and productivity of fodder.

1.2.6 Crop residues being main basal diet for dairy cattle play vital role in maintenance of large population of animals.

1.2.7 Majority of residues have low bulk density & are poor source of nutrients. They need enrichment and densification for reduced storage and transport costs.

1.2.8 Modern straw enrichment and densification plants are to be propagated.

1.2.9 The efforts to improve production and availability of fodder by the government are not sufficient to meet the demand of fodder.

1.2.10 In view of above, it is necessary to implement various programmes related to fodder development in a focused way.

1.2.11 Under NLSIP, fodder development programmes have been formulated with the objectives to enhance the fodder availability for the livestock.

1.2.12 Through fodder development programmes, our focus is to improve the availability of green fodder by increasing the green fodder yield of cultivated fodder from the land already under fodder cultivation. This is important particularly in view of that there is very little scope to increase the area under fodder cultivation due to growing demand of human beings for food, fibre and shelter. It is therefore necessary to increase the productivity of cultivated and common grazing land per unit area.

1.2.13 Besides enhancing green fodder yield, there is need to improve the efficiency of fodder utilization and minimizing the fodder wastages to increase the overall availability of green as well as dry fodder and to reduce the gap between demand and supply.

2. **Rationale of the Program**

2.1 Effort to increase livestock productivity / production is constrained by feed / fodder shortages. The shortages tend to be even more serious during natural calamities.

2.2 To improve the availability of fodder, there is very little scope to increase the area under fodder cultivation, particularly in view of the growing demand of human beings for food, fiber and shelter.

2.3 It is therefore necessary to increase the productivity of available forage resources per unit area, improve the efficiency of fodder utilization and minimizing the fodder wastages to increase the availability of fodder and to reduce the gap between demand and supply.

3. Advantages of Fodder Development Program

3.1 Enhance productivity of green fodder from the cultivated land.

3.2 Enhance fodder productivity of common grazing land.

3.3 Create awareness among farmers about adoption of various technologies like use of improved seeds, conservation of surplus fodder in the form of silage, use of fodder harvester to recover crop residues from the combine harvested field.

3.4 Enhance production and use of certified/truthfully labelled seeds of improved varieties of fodder crops.

3.5 To organize timely supply of improved seeds of fodder crops at competitive price to the milk producers.

3.6 To enhance income of seed growers by paying a premium over grain for the production of certified/ truthfully labelled seeds.

3.7 To arrange supply of fodder to the land less/ marginal farmers from the common land.

3.8 Enhance livestock productivity through better feeding of green and dry fodder.

3.9 To improve the income of the farmers through improved livestock productivity by better feeding of green & dry fodder.

4. Prerequisites of Fodder Development Program

4.1 Fodder development programs would be implemented through suitable LIA.

4.2 The prerequisites of the fodder development programme would be as follow:

4.2.1 The area for implementation of fodder development programme will be identified considering availability of livestock, green and dry fodder, common grazing land and agro–climatic conditions conducive to production of fodder seeds of specific crops.

4.2.2 The area identified for implementation of fodder development program should have any of the above mentioned agencies willing to implement the program.

4.2.3 The implementing agency agrees to implement the program as per norms laid in the technical and operational guidelines of fodder development program.

4.2.4 The lead implementing agency has sufficient manpower to implement the program.

5. Components of Fodder Development Programs

5.1 Various components under the Fodder Development

5.1.1 Production and marketing of certified/truthfully labelled fodder seeds of improved high yielding varieties.

5.1.2 Creation of required infrastructure for fodder seed production, storage, processing, treating, packaging and marketing.

5.1.3 Re-vegetation of common grazing land for fodder production.

5.1.4 Improve technical skill of the manpower through training.

5.1.5 Organize on farm demonstrations of following technologies to popularize among farmers for their adoption.

5.1.5.1 Silage making demonstration to conserve surplus fodder.

5.1.5.2 Demonstration of mowers to recover crop residues.

5.1.5.3 Introduction of biomass store.

6. Objectives of the program

6.1 The main objectives of the fodder development program are:

6.1.1 Enhance green fodder yield of cultivated fodder crops from the land already under fodder production.

6.1.2 Improve efficiency of fodder utilization.

6.1.3 Minimize fodder wastage.

6.1.4 Re-vegetation of common grazing land for fodder production.

6.1.5 Training of technical manpower.

6.1.6 Consistent with the above main objectives, the following activities will be implemented:

6.1.6.1 Fodder yield of cultivated fodder crops to be enhanced

6.1.6.2 Increase seed production of fodder crops

6.1.6.3 Enhance use of quality fodder seeds

6.1.6.4 Fodder utilization efficiency to be increased

6.1.6.5 Silage making demonstration

6.1.6.6 Fodder wastage to be reduced

6.1.6.7 Demonstration of fodder mowers and pick up devices

6.1.6.8 Demonstration of biomass stores

6.1.6.9 The program would be implemented in areas where the agro-climatic conditions are suitable for fodder development.

6.1.6.10 For silage making, areas where maize, sorghum, pearl millet, oats etc are generally grown would be selected.

6.1.6.11 To organize 1050 silage making demonstrations in selected villages.

6.1.6.12 Re-vegetate 100 hectares permanent common grazing land for fodder production.

6.1.6.13 The productivity of such lands can be raised from the present level to 10% higher level.

6.1.6.14 For all activities special care to be taken to trigger fall out effect in the milk sheds so as to achieve higher adoption rate by neighbouring farmers.

6.1.6.15 Various demonstration programs, besides reducing wastage and increasing efficiency will also create awareness about usefulness of latest fodder management technologies.

7. Project Sub Activities

7.1 Fodder seed production, processing and marketing programme

7.2 Green fodder, an important and economic source of macro and micro nutrients for the livestock, is deficit significantly.

7.3 Presently, the fodder cultivation land is low and with lower productivity

7.4 The low fodder yield is mainly due to huge deficit of quality fodder seeds of improved high yielding varieties/hybrids of various fodder crops.

7.5 It is expected that by use of improved fodder seeds along with recommended agronomical practices, fodder yield can be enhanced substantially from the present level each year, considering production potential of improved varieties.

7.6 Despite various efforts, the availability of quality fodder seeds still remains a major constraint in stepping up fodder production matching the demand for milk production.

8. **Key performance indicators of the activity**

8.1 Procurement of breeder seeds as per project proposal.

8.2 Production of certified/foundation/ truthfully labeled seeds as per targets.

8.3 Quantity of certified seed marketed.

8.4 Per cent increase in proportion of area under green fodder with certified / truthfully labeled seeds.

8.5 Silage making demonstration: In order to ensure supply of fodder to livestock during lean/ deficit period, the fodder conservation of any surplus quantity of green fodder is the best option.

8.6 Among various technologies available for fodder conservation, silage making (fodder ensiling) is most efficient because large quantity of green fodder can be preserved for longer period during any season without any significant loss of fodder quality and palatability.

8.7 Silage making is not popular among farmers in Nepal and it is necessary to educate the farmers about silage making by organizing demonstration at the village level.

8.8 Through silage making, wastages of the green fodder produced during flush season (mainly during rainy season) can be minimized thus improving fodder utilization efficiency.

8.9 Tasks: Silage making demonstration at farmers' door steps

8.10 Technical criteria for participating in Silage Making Demonstration Fodder Crops: Maize, Sorghum, Pearl Millet and Oats: LIAs should have a network of village level farmers and having experience in conducting demonstrations for technology transfer at field level.

8.11 LIAs should have capacity to formulate and implement a sound plan for demonstrations.

8.12 Sequence of Activities: Identification of village/ farmers

8.13 Selection of appropriate Silo structure as per village conditions

8.14 Design & Construction of silo structure as per soil profile.

8.15 Supply of polythene sheet to the farmers

8.16 Briefing to farmers about harvesting, chaffing and silage making at highest possible speed

8.17 Arrange demonstration to other farmer

8.18 Key Performance Indicator: Number of farmers seen the demonstration of silage making

8.19 Silage is a preserved green fodder having high moisture around 65-70 percent. It is preserved from the fermentation of sugars available in the green fodder in the absence of oxygen (anaerobic fermentation).

9. **Procedure of Silage Making:**

9.1 Construct a surface/trench Silo (silage storage structure). One cubic meter space / silo can store 500-600 kgs of green fodder.

9.2 Harvest the crop at 30-35 percent dry matter stage.

9.3 Wilt the harvested fodder to bring down DM to 30-35 percent, if required.

9.4 Chop the fodder into small pieces of 2-3 cm size.

9.5 Fill the chopped fodder into the silo.

9.6 Press the chopped fodder in the silo layer by layer of 30- 45 cm.

9.7 Filling and pressing should be as fast as possible.

9.8 After filling and pressing, seal the silo with thick polyethylene sheet.

9.9 Put weight through mud layer/ sand Bags/ tires on the sheet to prevent air flow beneath the sheet.

9.10 Open the silo for feeding, minimum after 45 days, as per need.

10. Advantage of Silage Making

10.1 Minimize wastage of surplus green fodder produced during flush season.

10.2 Ensure round the year fodder supply to the livestock.

10.3 Ensure harvesting of maximum nutrients available in fodder crop.

10.4 Crop can be harvested in almost all weather condition.

10.5 Silage feeding requires minimum adjustments in balancing the ration as it is of almost uniform quality.

10.6 Feeding silage reduces bloat and also an effective tool for the control of parasitic diseases, as the micro-organisms present in the green fodder are destroyed during ensiling.

10.7 Enhance green fodder productivity by improving harvesting intensity

10.8 Enhance livestock productivity by ensuring fodder supply during deficit.

11. Crops suitable for silage making

11.1 The fodder crops rich in soluble carbohydrates, such as maize, oats, sorghum, pearl millet, and hybrid Napier are most suitable for ensiling.

11.2 The silage of other crops can also be made by using suitable additives.

11.3 Infrastructure required: Silo – Surface or trench.

11.4 Farm machinery like fodder harvester & power chaff cutter tractor, trailers etc.

11.5 Progressive farmers are to be encouraged to create rudimentary infrastructure for ensiling.

11.6 Surface silos in the capacity range 5 to 15 MT to be constructed using locally available building materials like bricks, stones, gravel, sand, cement, steel etc. For manual pressing the brick /stone wall height of 1200 to 1500 mm would be provided.

11.7 Proper foundation and finished floor levels to be considered as per local village conditions mainly soil, flooding, water table, runoff water etc.

11.8 General schematic sketch of surface silo for the progressive farmers will be provided.

12. Characteristics of good quality silage

12.1 Bright, light green yellow or green brown in colour.

12.2 Lactic acid odour with no butyric acid and ammonia odour.

12.3 Firm texture with softer material not easily rubbed from fiber.

12.4 Moisture is 65-70 percent.

12.5 Lactic acid 3-14 percent.

12.6 Butyric acid less than 0.2 percent.

12.7 Acidic medium with pH 4.0 -4.2.

Section 3

Priority Investment Recommended by assessments – Feed and Animal Nutrition

The Priority Investment Recommended by assessments – Feed and Animal Nutrition has been prepared and summarized in this section as following;

Priority investments recommended by assessments – feeding										
SN	**what - activity/investment**	**Quantity**	**unit cost (NPR Million)**	**total investment NRs Millions**	**physical units 2019/20**	**Location**	**2020/21**	**2021/23**	**2023/24**	**comment - investment supporting public/private sector**
1	Ration Balancing Program	200 Modules Each module 50 villages, 1000 animal	19.8	3960	50 Module	Different 50 location s	physical units	physical units	physical units	
2	Mineral Mixture. Plant	4	5.0	20.0	4	1.Biratnagar, 2. Hetaunda, 3.Butawal, 4. Pokhara				
3.	Silage Making Bails	4	0.875	3.5	1	Biratnagar	1	1	1	
4	Chaff Cutter	200	0.05	10.0	50	Different locations	50	50	50	
5.	UMMB	4	4.0	16.0	2	Different locations	1	1		
6.	TMR	2	200	100	1	Butwal		1		
7	By pass Protein Plants	4	20.0	80.0	1	Biratnagar	1	1	1	
8	Strengthening QC labs	4	37.5	158.0	4	Biratnagar Hetaunda Butwal Pokhara				
9	Calf rearing programs	5	13.2	151.0	1	Biratnagar	2	1	1	
10	Irrigation Facilities	1								

11	Fodder nursery NLSIP districts and RARS Rasuwa NARC farm, GRS, bandipur NRAC Farm) and public farm at Biratnagar, Hetaunda, Nabalpur, Butawal and Pokara).	50	0.05/site	2.5	50					
12	Procurement of certified/ Truthfully Label fodder seeds (Maize, sorghum, oats, beerm, (Mt)	500	0.5/mt	250	125		125	125	125	
13	Capacity Development	5								
13.1	Training Fodder production (Officer	5								
13.2	Training on Ration balancing (officers)	5								
14.	Observation visit (INDIA, and Thailand (seed production) senior level.									As discussed in the main documen
	1.Policy level	4								
	2.Senior Level	3								
	3. Officers	4								

*** The end***