Draft

Balance Sheet of Animal Feed and Forage Seed of Nepal and Impact Study of Forage Mission Program

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ACRONYMS AND ABBREVIATIONS

CFUG	Community Forest User Group
DE	Digestible Energy
DLS	Department of Livestock Services
DM	Dry Matter
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GEOBIA	Geographic Object Based Image Analysis
HH	Household
HICAST	Himalayan College of Agricultural Science and Technology
ICIMOD	International Centre for Integrated Mountain Development
INGO	International Non-Governmental Organization
IRDS	Institute of Research and Development Studies Pvt. Ltd.
KUBK	Kisanla Lagi Unnat Biu-Bijan Karyakram
LFUG	Leasehold Forest User Group
LRMP	Land Resource Mapping Project
LSS	Livestock Service Section under the Municipality
LU	Livestock Unit
LULC	Land Use and Land Cover
ME	Metabolizable Energy
MoALD	Ministry of Agriculture and Livestock Development
MoLD	Ministry of Livestock Development
MT	Metric Ton
NAFLQML	National Animal Feed and Livestock Quality Management Laboratory
NARC	Nepal Agricultural Research Council
NASRI	Nepal Animal Science Research Institute
NGO	Non-Governmental Organization
NRC	National Research Council
TDN	Total Digestible Nutrients
TMR	Total Mixed Ration
UMB	Urea Molasses Block
VAHW	Village Animal Health Worker

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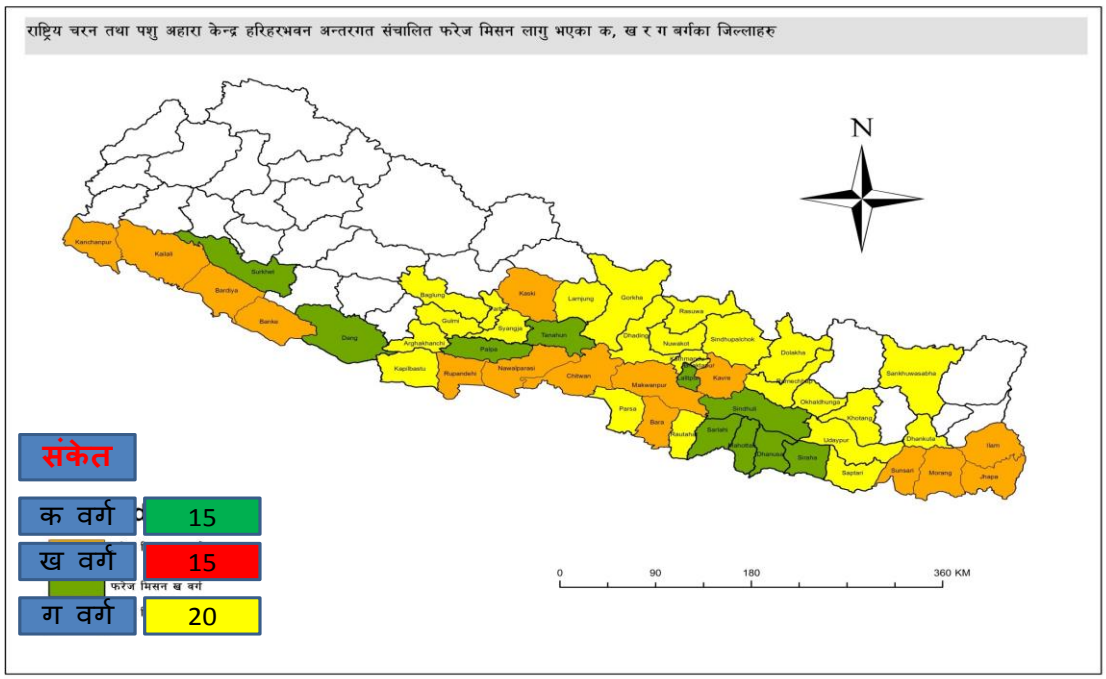
TABLE OF CONTENTS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EXECUTIVE SUMMARY

1. Institute of Research and Development Studies Pvt. Ltd. undertook this study for National Animal Feed and Livestock Quality Management Laboratory (NAFLQML) of the Department of Livestock Services (DLS) with twin objectives of: (a) updating the livestock feed balance; and (b) assess the impact of forage Mission, which was implemented during 2069/70 to 2074/75. Therefore, they are dealt in two separate chapters.

Chapter I: Feed Balance

2. The study utilized the land use data generated by the International Centre for Integrated Mountain Development (ICIMOD) in 2010 (the latest), using geographic object-based image analysis (GEOBIA) employing Landsat images. The ICIMOD data were in the raster format, which were clipped by using ArcGIS 10.4 version. The district data were then congregated into provincial and eco-belt database. Remote sensing and geographical information system were used to finalize these data sheets.

3. In the absence of adequate studies on forage productivity of forests, shrub lands, grasslands, croplands (weeds) and barren lands, and use of kitchen wastes as animal feeds, LRMP (1986) figures remained the main source of data for TDN supplies. MoALD (2016/17) data were used to estimate the supply of TDN from crop residues and milling by-products by district.

4. Estimates for feed requirements was based on MoALD (2016/17) data on livestock and livestock production by district. The livestock numbers were converted into Livestock Units (LUs) by using factors as agreed with the national experts. Separate estimate was done for TDN requirement for milk production. Requirements for poultry, fish and swine were estimated in terms of use of grains and by-products and their conversion into TDN. Requirements for draft animals were adopted from Oli (1984) and Sen, Ray and Ranjhan (1978).

I.1 Findings

5. There have been significant changes in livestock population since 1980 when LRMP survey was undertaken. In 2016/17, the **Livestock Unit has increased by 1.58 times** with increase in poultry population by 118 times, pig population by 3.6 times, sheep and goat population by 2.1 times and cattle and buffalo population by 1.3 times compared to 1980. This increase has **enlarged the feed demand** dramatically to 12.257 million MT which is higher by 1.3 times than the estimate of 9.461 million MT made by Rajbhandary and Pradhan (1991).

6. There have also been significant changes in land use and crop production. Since 1990, forest area had declined by 7% and grassland by 26.8%. At the same time, agricultural land has increased by 7.6% and barren land by 52.5%. Also noted was a dramatic increase in crop production and hence their residues and the milling by-products since 1986. **Crop production has increased at least by 2.15 times** and the average crop yields by 1.49 times. These changes have increased TDN supply from crop residues and milling by products by over 3 times compared to 1980's. In addition, improved fodder production has dramatically increased from 36ha on 1980 to 3,7154ha in 2016/17 contributing about 7% of total TDN supply.

7. Consequently, the **feed (TDN) balance at national level has dropped from 30.9% in the 1980's to 17.56% in 2016/17**. However, it was noted that the livestock feed even now is highly imbalanced, as straws constitute over 65% of total TDN supply, and makes up the major diet (>80%) during the winter and the dry summer.

8. **By ecological belts**, the feed deficit is the highest in the Mid Hills (-22.25%) followed by Terai (-15.39%). The feed situation in the high hills is more or less balanced, although the estimate shows a deficit of -2.85%.

9. **By province**, Province 6 seemed to be in comfort zone with +6.85% TDN balance. Province 1 and 3 were at severe feed deficit situation at -29.82% and -32.6% respectively. Feed deficit in the remaining provinces ranged from -6.21% to -13.86%.

10. When examined the **future feed balance**, the feed deficit is expected to reach -28% in 2021/22 and -32% in 2026/27, if additional forage intervention does not take place (which will not be true) either in the form of expanded forage area, introduction of high yielding forage crops or adoption of double or triple cropping. However, if the requirements of only the grazing animals are considered excluding pigs, poultry and fish, the feed balance is only 8.26% (-), which will swell up to -18.18% for 2021/22 and -20.98% for 2026/27. This indicates that presently the livestock in Nepal are not in bad shape in terms of gross TDN supply as people estimated, when considered the TDN balance without pigs, poultry and fish. Paradoxically, however they suffer from over-supply during the rainy season and critically under-supply during the winter and the dry summer.

11. **Forage Seed Demand**: Based on the need to bring new lands under fodder cultivation each year under different cropping options to meet the growing TDN demand, the seed demand is estimated. Depending upon the cropping option, the **seed demand may be as high as 15,116 MT per year** under multiple cropping systems. At the moment **national seed supply is 1,315 MT**, which is at least **11 times less than the requirements** estimated even under the proposed system.

I.2 Recommendations

1. **DLS forage production should focus on on-farm production** due to (a) increasing predatory habitats and declining ground forage in the forests with increasing tree canopy closure; and (b) declining farmers' interest to take their animals to the forest grazing due to migration of youth for remittance.
2. **Pasture development in the high hills should be accompanied with investment projects in the livestock sector.** High hills keep the highest potential for livestock production in the country due to its endowment with large tacks of rangelands. This requires improvement of productivity of rangelands. However, the pasture improvement programs should go hand-in-hand with an implementation of livestock sector investment projects for any observable results.
3. **Promote double or triple fodder cropping**: Given the small landholding and shortage of feeds particularly during the winter and dry summer, there is a need of promoting double or triple fodder cropping system for doubling or tripling the nutrients production per unit land area. At the same time silage making should be rigorously promoted.
4. **Promote land-leasing system:** Land is the limiting factor for fodder production for balanced feeding to commercial herds. Therefore, the DLS should facilitate land leasing system for feed development by working with the dairy farmers, their organizations and the local municipality through awareness raising on the value of balanced feeding e.g., (a) the value of green forage; and (b) limitations on the use of straws to dairy animals.
5. **Replacement of local cattle with improved breeds:** This is possible only when milk marketing outreach is extended, by working with the dairy industries for marketing of raw milk and more importantly the milk products manufactured at local level in an organized way. The later approach can help expand new areas for dairy production.

Chapter II: Impact of Forage Mission

12. Forage Mission was implemented with an objective of increasing livestock productivity and production through production of sufficient green matter covering additional 45,000ha under forage production in 45 districts and reduce feed deficit from 8.3 million MT to 7.1 million MT. Major activities undertaken could be broadly classified into five broad categories: (a) forage seed production and supply; (b) forage production; (c) forage conservation; (d) supply of machineries and equipment in support of forage/seed production; and (e) capacity development.

II.1 Findings

13. The forage Mission had been successful to achieve a significant annual compound growth rate of 112% in forage seed production through strengthening forage resource centres and encouragement of the private seed growers on contract seed production. However, the resource centers were concentrated in a limited number of districts with no attention to Province 6 in this regard. The resource centres for seed production of temperate pasture species were also limited.

14. With increased seed production, land coverage with forage and pasture reached 37,154ha at national level. This increased the TDN share of improved fodder and pasture to 7% at the national TDN supply from among the different feed sources. The field survey indicated that on-farm forage supply has increased from 34.4% to 53.8% (19.4 percentage points) with simultaneous decrease in straw use by 13.1 percentage points (n=225) (Table 38). This intervention also decreased the dependency of fodder on forest by 6.3 percentage points compared to before Mission. Before the launching of forage Mission, straw contributed over 46% of total diet of animals, which decreased to one-third after the Mission**.** Impact could be observed with increased milk production by an average of 26%, improved animal body condition by 29% and reduced labor hour by 4.4 hour per day. It addition, decreased use of straw will have a meaningful contribution to negating impact of climate change due to rumen fermentation.

15. Silage making, the other important intervention was appreciated silage as the most useful livestock feed and suggested to expand silage program more rigorously. This indicates that silage program was successful to create farmer awareness in livestock feeding.

16. The Mission also supplied small machineries and equipment to the livestock raisers in support of forage /seed production and post harvest activities. It also supplied machineries for hydroponic forage production and azolla farming. Among the machineries supplied, support for chaff cutter, water pumps for irrigation and harvesters were rate **satisfactory to moderately satisfactory**. Rest of the machines like TMR machine, feed grinder and mixture machine, thresher, UMMB machine and the seed fund were rated **Unsatisfactory**. The support for hydroponics and TMR production were also rated **Unsatisfactory**.

17. Finally, the application of training skills was 43.7% indicating that most of the training were not effective enough to meet their objectives. Surprisingly, farmers rated the in-country observation tours also not very effective. This indicates that the tours were not objectively defined based on farmer needs.

II.2 Recommendations

1) **Strengthen Existing Forage Resource Centres:** The existing resource centres should be developed as knowledge-cum-resource centres for livestock feeds and feeding. Their capacities to produce and supply seeds and seedlings should be expanded and strengthened through (a) facilitating contract farming, (b) equipping these centres with all necessary seed sowing, weeding, harvesting, processing and storage facilities, and (c) delivery of forage extension program with defined the crop priorities under objective contract. Concurrently, these centres should be utilized to develop their

sister centres for knowledge and feed resources. This strategy is expected to produce more outputs than the traditional method of forage extension.

2) **Matching grants should be project based/demand led**: Shortage of labor is critical in all rural areas. Mechanization of forage and forage seed production system can be achieved by providing matching grants for purchase of machines and equipment by following project based approach where the proponents submit business plans.

3) **Promote optimum input based fodder and pasture development program**: The concept of low to no input based forage and pasture development should be replaced with adoption of yield optimization technologies. Without irrigation and fertilization, forage or pasture block development efforts in the past had been futile. Similarly, the pasture development activities in the high hills will be ineffective if there is no investment in the livestock sector. Therefore, **pasture development activity in the high hills should be coupled with an investment project**.

4) **Need to prioritize the fodder and pasture crops:** Giving equal emphasis to all forage crops takes away resources but produces little outputs and impacts. There is a need of prioritization of forage crops with emphasis on silage making and winter growing crops with high productivity and high nutritional value

5) **Develop "fodder tree blocks" in the barren or uncultivated lands:** Fodder trees could be planted in large blocks (more than 10 ropani) in private of barren or uncultivated lands with priority to individual ownership. For this the government should support the farmers in fencing the area. This could be an important intervention in the goat pockets and an incentive to the farmers to utilize the uncultivated lands for productive purpose.

6) **Promote commercial silage manufacturers:** There are a few entrepreneurs coming up with commercial silage production. However, there is a need to establishing such enterprise in all provinces by providing matching grants based on business plan. While the enterprises will be responsible for contract farming management, silage production and marketing, DLS/municipal livestock sections may have a role of providing support to farmers in developing irrigation system, quality control and encouraging farmers to use silage.

7) **Stop implementing subsidized activities where private sector investment would be more appropriate:** Distribution of equipment such as grinder and mixture, UMMB machine and TMR machine should not be DLS intervention. These are the areas where the private sector can contribute. DLS could promote the private sector by facilitating the lending process, sharing technologies and quality control.

8) **Emphasize on objective exposure visits:** The exposure visits should be objectively defined before they are implemented. This will require assessment of farmer needs and organizing visits to meet their needs.

9) **Need for focused forage research:** There is s need of focused research on improving forage and seed productivity and reducing cost of forage/seed production. For this, DLS should be working together with NARC and Fodder/Seed Producer groups for identifying appropriate research areas and managing research activities. Secondly, the NARC research system should be improved by working beyond the research outputs. Rate of adoption of research outputs should be part and parcel of the research activities. Thirdly, there is a need of developing appropriate method/s of making silage from crops other than maize with grain cobs. First priority crop would be silage making from napier an local grasses. Such trials should be multi-locational and multi-agency e.g., NARC, University and DLS. Fourthly, the DLS in consultation with NARC and experts should import winter growing crops, test them and put them in the extension system

after field verifications. Finally, DLS and NARC should also study the productivity of local species in terms of biomass production and nutritive values. The promising ones would be those that are evergreen and supply fodder during the winter and/or summer. Study of selected indigenous species in the recent study could be a good start.

10) **Need for introduction/replacement of forage seeds**: It is important to note that many forage seeds imported long time back in Nepal require replacement. Attention is also required to import, test and multiply species such as tropical rye grass and lucerne. To make this program successful, there is a need of establishing a network for production and distribution of foundation and certified seeds.

11) **Establishment of gene banks**: The on-going study on "Indigenous Species of Forage and Strategy for their Conservation and Promotion" indicates that there are a unexplored forests species which make up the major feed of livestock in general and of goat in particular. There may be many more species when exploration undertaken countrywide. There is a need of giving adequate attention to identify them, test and multiply at farmer level. The seeds of such species should also be stored in the forage gene banks. The government should encourage farmer groups also to establish such gene banks.

12) **Establishment of database**: Inadequate or lack of documentation was one of the limiting factors in carrying out the present field study. There is a need of establishing strong database at central and municipal level on inputs and outputs, which provide clear view as far as the effectiveness of investment is concerned and information for future planning.

Balance Sheet of Animal Feed and Forage Seed of Nepal and Impact Study of Forage Mission Program

A. Introduction

1. Livestock is an integral part of farming system in Nepal. Its contribution to national economy is about 13%. Livestock is increasingly valued for food security and youth employment. The livestock populations by species are given below in Table 1a & Table 1b. Major ruminant livestock are the cattle and buffalo. The number of Yak/Chauries is insignificant (about 0.4% of total large ruminants) in terms of total national population, despite their important role for the people living in the high hills.

2. More than half (54.6%) of the population of large ruminant animals are above 3 years, and one-third under one year of age. Animals between 1 and 3 years constitute only 12.3% of total population. Most of these animals are local breed. The improved animals comprise only 3.4% in case of cattle and about 4.3% in case of buffalo. They produce 1,911,239 MT of milk (65% buffalo milk). Buffalo also produce 180,080 MT of meat annually.

Table 1a: Large Ruminant Population (Ministry of Livestock Development 2017)

Category	Cattle			Buffalo			Yak/ Nak
	Local	Improved	Total	Local	Improved	Total	Total
Under one year	780,486	49,303	829,789	3,035,876	138,513	3,174,389	7,030
1-3 year	835,369	32,024	867,393	587,088	24,436	611,524	5,828
Above 3 year	4,598,470	134,744	4,733,214	1,754,619	77,418	1,832,037	36,007
Total of all	6,214,325	216,071	6,430,396	5,377,583	240,367	5,617,950	48,865

3. The population of small ruminants is about 11.9 million, of which goat population comprise 95% and the remaining is sheep. Animals above six months comprise about 70% of total population. Improved animals comprise 2.7% in case of goats and 0.5% in case of sheep. However, these compositions are dynamic and change over time within a year or between years. They produce 70,420 MT (95% goat) of meat annually.

Table 1b: Small Ruminant Population (Ministry of Livestock Development 2017)

Species/category	Goat			Sheep		
	Under 6 months	Above 6 months	Total	Under 6 months	Above 6 months	Total
Total	3,509,526	7,715,605	11,225,131	173,330	439,554	612,884
Local	3,398,436	7,524,980	10,923,416	171,430	438,586	610,016
Improved	111,090	190,625	301,715	1,900	968	2,868
Percent improved by category	3.2%	2.5%	2.7%	1.1%	0.2%	0.5%

4. The non-ruminants constitute pigs, poultry and equines (horses/ mules/asses/ donkeys). Pig population is 0.87 million with 7.3% improved (MoLD, 2017). Just above half of the pig population (55%) is above six months of age. They produce 24,535 MT of meat annually. Similarly, chicken population is about 68.6 million (18% laying) and duck population, 392 thousand with 47% laying (MOALD 2017). Of these the commercial poultry birds account for 14.5 million. Altogether, they produce 57,509 MT of meat (96% chicken) and 1,352 million eggs annually. The population of horses/ mules/asses and donkeys is about 68,711.

5. While the ruminants and equines depend mostly on feeds available on private and common property resources, the rural poultry and pigs depend on scavenging, and the commercial stocks on concentrate feed mixes. Rajbhandary and Shah estimated that the feed deficit was about 34% in terms of Total Digestible Nutrients (TDN) during the 1980's. In 2006, Upreti & Shrestha reported an overall deficit of 29% TDN. This difference could be associated mainly with the changes in crop production as being the largest source of feeds in the form of crop residues, continuous effort of the Department of Livestock Services (DLS) in forage and pasture development during the last two to three decades and also the differences in the kinds of coefficients used in determining the harvesting indices of crops and milling by-products and their nutritional values (TDN) used therein. Nevertheless, it has been accepted that the livestock sector in Nepal suffers from feed deficit. While the rainy season is at surplus, the winter and the spring seasons (Oct to May) are at severe deficit. The poultry sector depends mostly on import of feed ingredients from India.

6. Since then there have been significant changes in land use pattern, livestock population and the farming system in Nepal. Therefore, the National Animal Feed and Livestock Quality Management Laboratory undertook a study in 2018 to prepare a feed balance sheet. However, this study used the land use pattern estimated during 1980-85 by LRMP and there were some inconsistencies in data management. Therefore, the Institute of Research & Development Studies had been entrusted to update the findings of this study.

7. In addition, the distribution of seeds and seedlings/slips of improved forage species to the farmers has been a regular phenomenon of most development agencies including NGOs and INGOs that are engaged in livestock development in Nepal. However, the uptake of technologies has remained slow for various reasons. Therefore, DLS implemented "Forage Mission" from 2070/71 to 2074/75 (2012 to 2018) with an objective of increasing livestock productivity and production through production of sufficient green matter in the country. The targets were to: (a) bring additional 45,000ha land under forage production; (b) bring additional 150ha of land under oat and 30ha under berseem cultivation; and (c) reduce feed deficit from 8.3 million MT to 7.1 million MT. It had planned to cover 15 districts in Phase I, 10 districts in Phase II and 20 districts in Phase III. However, the impact of this Mission was not yet assessed. Therefore, this assignment also included an assessment of the impact of this "Mission".

B. Objectives

8. The overall objective of the study was to update the findings of the previous study undertaken in 2018 to assess the feed and forage demand and supply situation in the country. The study was also intended to assess the impact of forage Mission, which was implemented during 2070/71 to 2074/75. It was expected that the study report would serve as milestone for future policy adoption and formulate action plan for the development of feed and forage programs in the country. More specifically the study intended to:

a) Assess the current status of feed and forage production, import and stock;

b) Estimate current demand of animal feed and forage;

c) Based on the above, develop feed balance sheet; and

d) Recommend a comprehensive future road map for the sustainable development/ promotion of feeds and feed resources for the country.

C. Scope of the Work

9. The proposed study had the following scope of work:

a) Assess the amount of grain and grain-by-products supplied as animal feed, export, import and stock balance together with the import of processed feed.

b) Estimate the possible feeding material like molasses, oilseed cake, bran used as animal feed and evaluate what amount of rice straw and wild grasses cut off as industrial raw material.

c) Rationalize the feeding values (ME for poultry and DE for pigs and fish) of grains and by-products into TDN to be included in the overall feed balance estimation sheet.

d) Estimate the cereal grains used as feed for milking and pregnant animals as well as male goats for meat production.

e) Estimate the portion community and leasehold forest share in total supply of animal forage together with the wastage ratio of feeding material.

f) Assess the requirement of feed industry;

g) Confirm the data and analysis provided by the previous study, by using available raw data;

h) Prepare a livestock feed balance sheet at national and province levels based on feed supply and demand estimates;

i) Make action recommendations both at policy and implementation levels;

j) Assess the impact of forage Mission;

k) Future recommendations for forage development program.

D. Organization of Report

10. The team had been entrusted to undertake two separate studies in one go: (i) to update the feed database generated in 2018; and (ii) to assess the impact of Forage Mission that was implemented by the then National Pasture and Animal Feed Centre of the Department of Livestock Services (presently National Animal Feed and Livestock Quality Management Laboratory) during 2069/70 to 2074/75 (2012/13-2016/17). Therefore, the feed balance assessment has been presented in Chapter I, and the impact of "Forage Mission" in Chapter II.

Chapter I

Feed Balance

1. Methodology

11. Livestock feed balance is a function of land use pattern, crop production, livestock population, composition and production, and level of utilization of available feeds. Therefore, this study analyzed the feed availability by using mostly the secondary data such as land use pattern, change in crop production and accessibility to feed resources; and feed requirements by using nutrient requirement standards of different kinds of livestock, fish and birds. Focus group discussions were organized to supplement secondary data particularly those related to utilization of forest fodder. The following sections describe the reference methods for the study.

1.1 Review of Previous Report on Feed Balance

12. This study reviewed the latest study report (2018) of the National Animal Feed and Livestock Quality Management Laboratory on "Estimation of Supply & Demand of Livestock Fodder/Feeds and Forage Seeds." However, there has been significant changes in land use pattern and productivity of agricultural lands since the data generated by the Land Resource Mapping Project (LRMP) during 1980-86, the study utilized the data generated in 2010 by the International Centre for Integrated Mountain Development (ICIMOD). It also reviewed the annual reports published for the period covering 2012/13 to 2016/17 by the National Animal Feed and Livestock Quality Management Laboratory. Other reports reviewed included the feed balance studies and pastureland productivity studies undertaken by different authors in the past.

1.2 Data Collections and Updating

1.2.1 Estimation of Feed Availability from Forest, Grass Lands and Shrub Lands

13. LRMP (1986) data was the main source of data for TDN supply from forests, shrub lands, grasslands, croplands (weeds) and barren lands and kitchen wastes. ICIMOD data for land use and MoALD data for crop production, livestock population and production were the major basis for estimation of feed balance.

14. ICIMOD generated land use pattern data in 2010 by using geographic object-based image analysis (GEOBIA) using Landsat images showing a significant changes in land use pattern of Nepal since 1986. Therefore, the present study utilized the ICIMOD data in place of the LRMP data. However, since ICIMOD did not study the productivity of these land resources, nor was there any productivity study carried out since LRMP study except a few on productivity of alpine pasture lands, the present study utilized the LRMP productivity data such as per hectare production of Total Digestible Nutrients (TDN) from forests, grasslands, barren lands and agricultural lands (weeds), with the assumption that no significant changes have occurred since then due to lack of any discernible technical interventions except under leasehold forestry programme.

15. Miller (1993) reported an average productivity of 0.73 MT TDN/ha for alpine pasture lands. Similarly, Devkota and Kachhapati (2011), reported 0.64 MT/ha for pasturelands of Myagdi district. These two figures averaged out at 0.68MT TDN/ha. However, there are no detailed studies of grasslands in the mid hills and the terai. Therefore, the study of the Forestry Sector Master Plan of Nepal (1989) that reported MT TDN/ha production in the high hills, mid hills and the terai at 0.662, 0.235 and 0.103 respectively were utilized in this study. Similarly, there are no reports on detailed study on feed availability from community or leasehold forests. Many community forests are closed from grazing but open for collection of fodder one to three months a year, for various reasons. Similarly, the increased tree canopy has reduced fodder

availability in the leasehold forests. Under this situation, we assumed that the feed availability from these forests has remained more or less that of 1980's.

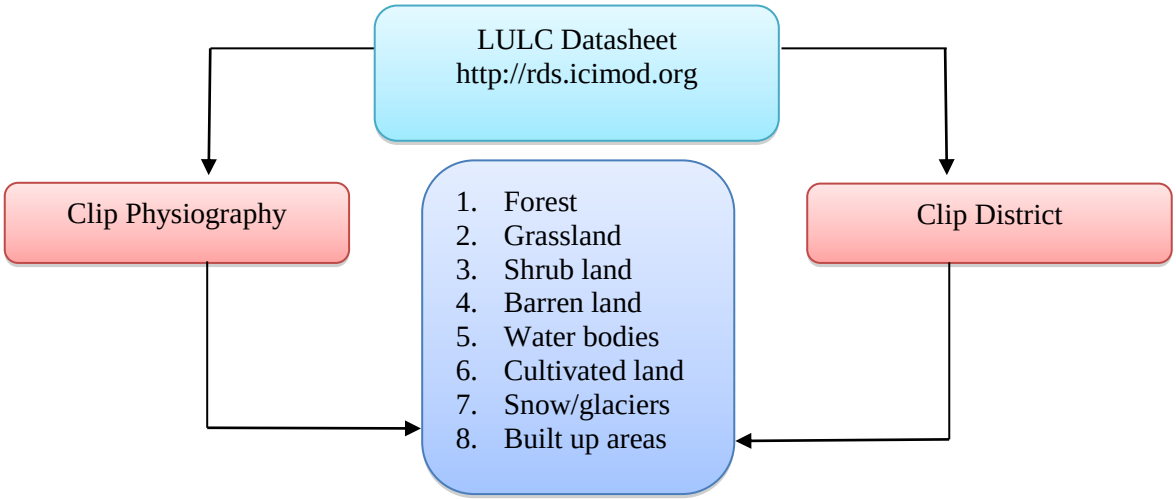
16. The data on crop residues and milling by-products were obtained from MoALD statistics (2016/17) and literatures. Personal communications with the national experts[1] and review of national and international literatures on conversion factor (harvesting index) for grain to crop residues or milling by-products (milling index) formed the basis for estimating feed supply from crops and their by-products. However, it must be agreed that the conversion factor varies by crop variety, agro-ecological differences, method of harvest and processing, and the method of data collection.

17. This study did not consider dry matter supply or animal demands for dry matter. It rather focused directly on supply and demand of TDN. Because, (a) TDN production per hectare of land resources were available from the LRMP records; (b) TDN values of crop residues, milling by-products and green fodder are available in any standard feed tables; and (c) dry matter estimate has little value in such exercises.

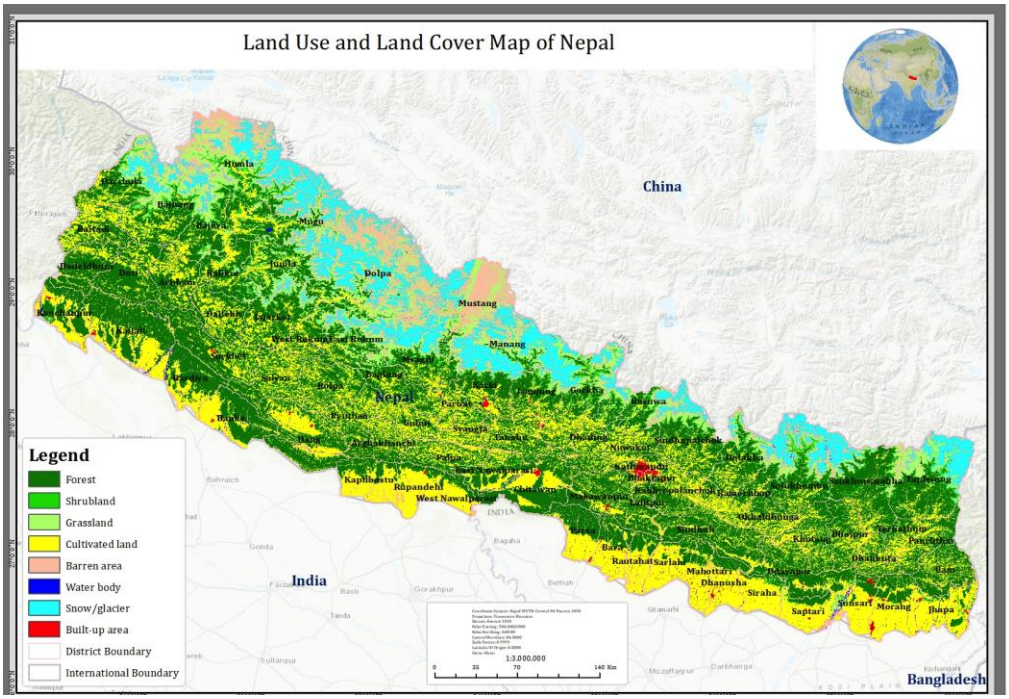
18. The Department of Forest and Environment was the source for number, location and area coverage of each leasehold and community forest present in the country. List of districts with leasehold forests are given in Annex 1.

19. Land cover refers to the physical characteristics of earth's surface, captured under the distribution of vegetation, water, soil and other physical features. Land use refers to the way in which land used by humans and their habitats (such as cultivated land, settlements, forest, shrub land, grassland, water bodies etc.). Although land use is generally inferred based on the cover, yet both the terms land use and land cover are closely related and are interchangeable. It has become a central component in current strategies for managing natural resources and monitoring environmental changes.

20. The land use and land cover (LULC) classification scheme used in this study had been derived from http://rds.icimod.org dating back to 2010. The classification scheme utilized eight LULC classes representing forest, grassland, shrub land, cultivated land, barren land, snow glaciers, water bodies and built-up areas. The ICIMOD data were in the raster format, which were clipped by using ArcGIS 10.4 version. The same algorithm worked for all LULC of districts, which were then congregated into provincial database. All these datasheets were finalized by using remote sensing and geographical information system with correct and accurate assessment. The process is described in the following schematic diagram.



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



21. ***Focus group discussions***; Focus group discussions (FGD) were conducted at user group level in Panchthar, Kavre and Doti districts representing three provinces to get a general view on the trends in the accessibility and level of utilization of forage available in the community and leasehold forests (Checklist given in Annex 2a&b). The FGDs were conducted with user groups of three community and three leasehold forests in each district. Thus a total of **18 focus group discussions {(3 sites of LHF+3 sites of CF)}*3 districts}** were conducted. Each FGD was conducted with 10-15 members and at least 7- 8 women farmers in case of community forestry, and at least 50% of members with 75% women in case of leasehold forestry. The FGD focused at current utilization of available fodder in these forests either by fodder collection system or by taking animals to the forests for grazing**.**

22. To get a general view on the level of utilization of on-farm fodder (both improved and local) available during the rainy season, particularly in areas where intensive perennial forage production has been promoted, individual household surveys were conducted by administering questionnaire as given in Annex 5.

1.2.2 Estimation of Feed Supply from Crop Residues and Milling By-products

23. MoALD (2016/17) data were also used to estimate the supply of TDN from crop residues and milling by-products. The estimates for straw burnt in the field, and use in mushroom production were from the study done respectively by Bhandari and Kafle (2017) and PACE Nepal Pvt. Ltd. (2012). Data on use of grains and by-products, molasses and import of feed ingredients used by feed industries were obtained from the Feed Industries Association of Nepal (2075).

1.2.3 Feed Demand Estimation

24. Estimates for feed requirements was based on MoALD (2016/17) data on livestock and livestock production. The livestock numbers were converted into Livestock Units (LUs) by using factors as agreed with the national experts[2]. One LU was considered for a 400kg livestock. Separate estimate for TDN requirement was done for milk production. The requirements for

[2] Dr. Megh Raj Tiwari, Director, NASRI/NARC, Dr. Krishna Prasad Paudel, Animal Health and Breeding Expert, and Prof. Dr. Naba Raj Devkota, University of Agriculture and Forestry, Rampur, Chitwan.

animals were based on NRC (2007). Requirements for draft animals were adopted from Oli (1984) and Sen, Ray and Ranjhan (1978).

25. Estimation of LU by breed was based on fitting the herd composition data from the then Ministry of Livestock Development (2016/17) into the same year MoALD livestock population data.

26. TDN requirement for fish was estimated from total annual fish production and its feed conversion ratio, and the feed ingredients that are commonly used. The TDN requirement for pigs was estimated by the estimated amount of feed consumption by age for their digestible energy (DE) requirements, and the TDN for poultry by converting the available metabolizable energy (ME) in the annual amount of feed ingredients used by the feed industries into TDN. These species though not very relevant in feed balance estimate, are included to meet the scope of work as specified in the Terms of Reference.

2. Limitations

27. The following were the major limitations while undertaking this study.

2.1 Estimating Cereal used as Animal Feeds

28. Data collection on amount of cereals used in animal feeds would require a special study involving large scale HH survey by herd type (commercial, semi-commercial, subsistence), herd composition (young, heifers, pregnant, milking and draft power), breed type (improved, local), farming system (stall-fed, grazed), level of production (milk and meat growth pattern), ecological belts (terai, hills and mountains) and province (east to west). This kind of study would require large amount of resources and time, therefore could not be undertaken for this assignment mainly due to resource and time constraint. Therefore, it has been assumed that farmers feed their livestock with cereals/by-products based on their own knowledge and availability of cereals at local level.

2.2 Developing Feed Balance Sheet

29. Following were the major limitations while developing feed balance sheet.

a) **Contentious livestock data sets**: The statistical information on livestock generated in 2016/17 by the then Ministry of Livestock Development (MoLD) contained information on livestock number by breed type (improved/local) but did not have data on production. At the same, the population differed significantly compared to the statistical information generated for the same by the Ministry of Agriculture and Livestock Development (MoALD, 2016/17) (Table 2). Nonetheless, the study utilized MoALD data by utilizing the breed desegregated data of MoLD.

b) **Lack of separate data of newly formed districts**: The livestock and crop production data for the newly formed districts were not available. Therefore, the data analysis continued to use the data of the previous 75 districts. The data from the previous district were divided equally to newly formed districts, where necessary.

c) **Lack of productivity data of forest/grasslands/shrub lands/farm weeds:** Limited studies have been undertaken on forage productivity of forest/grassland/shrub/barren land/farm supplies (fodder) since 1980's. There are also no data on forest accessibility and status of forest grazing. Therefore, the study completely relied on LRMP data, which were generated during 1980 to 1985.

d) **Lack of lifetime growth curve/pattern of Nepalese livestock**: Lack of data on growth curve of Nepalese livestock was a big challenge while estimating the Livestock Units (LU) for assessment of feed demand. There was no data on lifetime growth pattern. This was especially true in case of large ruminants and large non-

ruminants. The data available were only in bits and pieces. Therefore, the body weights were based on author's guestimate, of course with verification by national experts. However, many of these experts could also just guestimate.

e) **Lack of data on winter feeding system**: There is no data that specifies the ratio of green to dry roughage and the supplementary concentrate feeding during the winter and the dry summer. Generation of data by this study was not possible due to resource and time constraint.

f) **Limited studies on burning of straws on the field and use in mushroom production**: Some proportions of straws (paddy and wheat) are generally burnt on the field particularly in the terai. However, there were no adequate publications on this topic in Nepal. The data used is based on only one reference (Shrestha et.al., 2014). Similarly, the only data reported by PACE Nepal Pvt. Ltd., (2012) was the source for use of straw in mushroom production.

g) **Lack of data on commercial production and import of silage:** There is no formal data on commercial production and import of silage from India. The study used the information provided by the S. G. Cattle Fodder Industry in Ranighat, Birgunj on personal communication.

3. Findings

3.1 Livestock Population Database

30. The Ministry of Agriculture and Livestock Development (MoALD) and the then Ministry of Livestock Development (MoLD) generated two different sets of livestock data for 2016/17. While the MoALD generated livestock population and production data, the MoLD generated population data with breed desegregation (local and improved) but without any production data (Table 1). The MoLD statistics also did not provide any data on poultry. Further more, the data generated by MoLD also showed considerably lower figures for all species it covered except a 2% increase in goat population. Therefore, the MoALD data was used for feed demand estimates. However, the proportion of breeds as desegregated by MoLD was utilized to estimate the number of local and improved breeds while using the MoALD data. For estimating feed demand, MoALD (2017) data have been used for the reasons discussed above.

Table 1: Comparison of MoLD (2016/17) and MoALD (2016/17) Data on Livestock Population

SN	Types	Nepal				
		MOLD 2073/74 (2016/17)			MOALD 2073/74 (2016/17)	Differences (MoLD over MoALD)
		Local	Improved	Total		
1	Cattle	6,214,326	216,071	6,430,397	7,302,511	-12%
2	Buffalo	3,035,876	138,513	3,174,389	5,168,809	-39%
3	Yak/Chauri	48,865	-	48,865	NA	
4	Goat	10,923,416	301,714	11,225,130	10,986,114	2%
5	Sheep	610,017	2,867	612,884	800,658	-23%
6	Pigs	807,099	63,098	870,197	1,291,308	-33%
7	Rabbit	NA	NA	NA	32,213	
8	Equine	NA	NA	NA	55,808	
9	Fowl	NA	NA	NA	68,630,638	
10	Duck	NA	NA	NA	392,255	
11	Milking cow	NA	NA	NA	1,029,529	

SN	Types	Nepal				
		MOLD 2073/74 (2016/17)			MOALD 2073/74 (2016/17)	Differences (MoLD over MoALD)
		Local	Improved	Total		
12	Milking buffalo	NA	NA	NA	1,509,512	
13	Milk production. MT	NA	NA	NA	1,911,239	
14	Meat production, MT	NA	NA	NA	332,544	
15	Egg production ('000)	NA	NA	NA	135,229	
NA=Not available						

3.2 Changes in Livestock Population and Crop Production Since 1980

31. There have been significant changes in livestock population since 1980 when LRMP survey was undertaken (Table 2). Overall, the **Livestock Unit has increased by 1.58 times** with increase in poultry population by 118 times, pig population by 3.6 times, sheep and goat population by 2.1 times and cattle and buffalo population by 1.3 times. This clearly indicates that the feed demand should have increased dramatically.

Table 2: Changes in Livestock population and in 2016/17 over 1980

Species	Population, MoALD (2016/17)		Population in 1980 (FAO, 2005)	Changes over 1980 (multiple)
Cattle	7,302,511	12,540,666	9,400,000	
Buffalo	5,168,809			
Yak/Chauri	69,346			1.3
Goat	10,766,363	11,522,901	5,380,000	
Sheep	756,538			2.1
Pigs	1,341,584	1,341,584	375,000	3.6
Equine	55,808	55,808		
Fowl	68,941,223	69,322,039	586,000	
Duck	380,816			118.3
Total LU		8,495,536	5,372,000	1.58

Note:

(a) 2,279,604 LU equivalent has been added while estimating LU from milk production (1 LU=1.095MT TDN per year) in the present study.

(b) To make the LU compatible with the FAO data above, factors such as (i) 0.2 pigs =1 LU; and (ii) 0.01 poultry=1 LU were used.

32. At the same time, there has been dramatic increase in crop production and hence their residues and the milling by-products (Table 3). Since 1986, the **crop production has increased at least by 2.15 times** and the average crop yields by 1.49 times. Major changes could be observed in cereal and sugarcane production.

Table 3: Changes in Crop Production since LRMP (1986)

Year	Crop details					Changes over past years (multiple)	
	Production and yields in different years			2016/17			
	Crop	Production, MT	Yield (kg/ha)	Production, MT	Yield (kg/ha)	Production, MT	Yield (kg/ha)
1984/85	Paddy	2,709,430	1.97	5,230,327	3.37	1.93	1.71
1984/85	Maize	819,850	1.42	2,300,121	2.55	2.81	1.80
1984/85	Millet	124,430	0.93	306,704	1.16	2.46	1.26
1984/85	Wheat	533,720	1.18	1,879,191	2.55	3.52	2.16
1984/85	Barley	23,460	0.86	30,510	1.11	1.30	1.30
1984/85	Oil seed	84,030	0.66	214,451	1.03	2.55	1.57
1984/85	Sugarcane	408,260	23.36	3,219,560	45.47	7.89	1.95
2000/01	Lentil	143,084	0.88	254,308	1.23	1.78	1.39
2000/01	Chick pea	12,148	0.83	10,969	1.10	0.90	1.33
2000/01	Pigeon pea	20,936	0.87	16,497	0.97	0.79	1.11
2000/01	Black gram	21,599	0.71	19,499	0.83	0.90	1.17
2000/01	Grass pea	6,796	0.78	9,354	1.16	1.38	1.49
2000/01	Horse gram	5,241	0.62	5,690	0.90	1.09	1.44
2000/01	Soybean	17,470	0.84	29,061	1.23	1.66	1.46
2000/01	Other legumes	15,969	0.77	32,817	1.07	2.06	1.39
2010/11	Buckwheat	8,841	0.86	12,039	1.09	1.36	1.27
					Average changes	2.15	1.49

Source: Ministry of Agriculture and Livestock Development. Statistical Information on Nepalese Agriculture (2009/10 and 2016/17).

3.3 Land Use

33. There have been significant changes in land use pattern in Nepal since 1990 (ICIMOD, 2010). The most significant change can be observed in increased built up area and barren land by 65.5% and 52.5% respectively compared to 1990. Concurrently, the grassland area has reduced by 26.8% and forest area by 7%. Agricultural land increased by 7.6% and shrub land by 4.5% (Table 4). The increased areas of agricultural land and barren land have significantly increased the feed supply to the livestock compared to 1990 and before. This is one of the reasons that the current feed balance is relatively better despite a significant increase in livestock population and production since then.

Table 4: 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).

3.4 Sources of Feeds and TDN Supply

3.4.1 Available TDN (MT) by source

34. Major sources of livestock feeds were the crop residues and milling products, forest, and weeds and grasses from farmlands each contributing 44%, 20.5% and 15.1% of total TDN supply. Rest of the sources contributed less than 5% of the total supply (Table 5). The field studies conducted in limited locations indicated that forests contributed only 13% of livestock feed of the CFUG members and 56% of LFUG members in the mid hills. To be noted is that even with several years of DLS efforts to improve forage production and pasture development in the country it could contribute only about 7% of total supply. In aggregate, available TDN is estimated at 10.1 million MT, which is 1.5 times greater than the estimate (6.58 million MT) of the Master Plan for Forestry Sector (1989), under optimistic (moderate) scenario.

Table 5: 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.			

35. Interestingly, there is increasing use of silage by the commercial dairy farmers. About 40 MT of silage is produced and marketed daily in Nepal (personal communication S. G. Cattle Fodder Industry in Ranighat, Birgunj). There are reports that some dairy farmers use a significant quantity of Indian silage. Lack of import data restricted its inclusion as feed source in preparation of the present feed balance sheet. However, its share should not be significant in terms of total TDN supply.

36. One other thing to be noted is the declining forest grazing or collection of forage from the forests particularly in the hills and the Churia. The forest share has decreased from 33% during 2000/01 (Shrestha et.al., 2000) to 20.5% in 2016/17. There are four reasons behind it: (a) increasing threat of predators to livestock, hence restricting forest grazing; (b) lack of youth in the villages to take the animals in the forests for grazing or to go and collect fodder from the forests; (c) closing of most leasehold and community forests for grazing, which also leads to decreased fodder availability due to tree canopy closing. However, there are no studies that have documented the amount of decline in fodder supply from these forests. A glimpse of fodder supply from community and leasehold forests developed under the present assignment is given below.

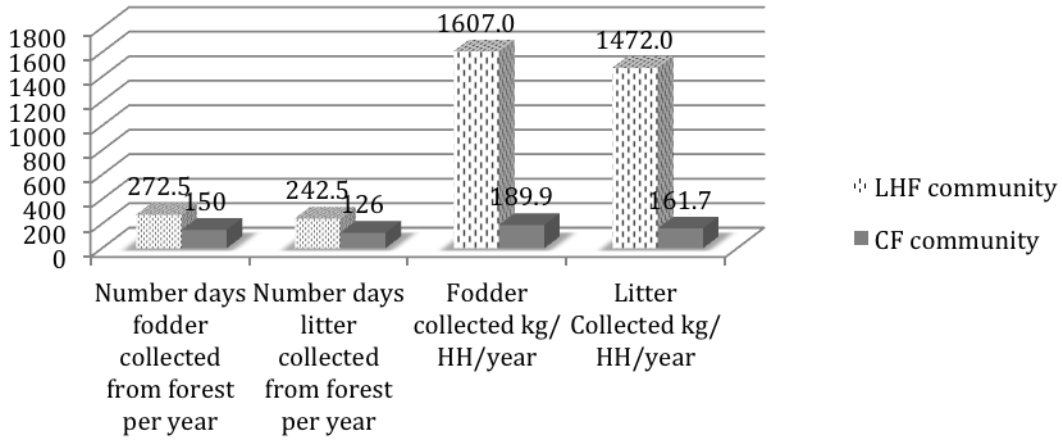
A Glimpse of Fodder Supply from Community and Leasehold Forests

a) *A mini survey was conducted in Panchthar, Kavre and Doti districts to get a view of level of utilization of leasehold and community forests. The study covered 12 leasehold forests and 10 community forests. The study indicated that 83.3% of leasehold forests and 60% of the community forests were at growing stages. The growth of rest of the forests were rated constant. On average, 97.8% of leasehold forest and 86.3% of community forestlands were completely restricted for animal grazing. Fodder and litter collection from these forests is however continued. Fodder and litter collection from forests by the LFUG members was higher (80% members) than by the members of CFUG members (30%). The LFUG members collected 1,607kg of fodder and 1,472kg of litter per HH per year. In contrast the CFUG members collected only about 190kg of fodder and 162kg litter per year per HH (Figure 1). This indicates that the use of community forest for fodder or litter collection is insignificant. In Panchthar, for example, only a small part of community forests is open for fodder collection. The rest is protected area for wild life, eco-tourism and new plantation.*

b) *About 73% of respondents collected forest fodder during Baishakh to Kartik and the rest collected year round. Similarly, about 64% respondents collected litter during Mangsir to Baishakh, about 9% during Asar-Shrawan and the rest 27% year round.*

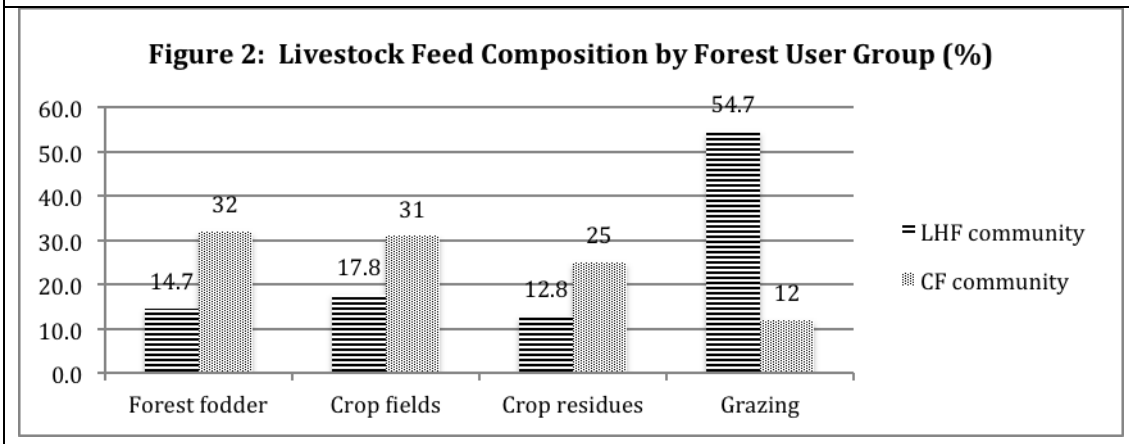
c) *While animals were grazed in the communal lands/forests from Baishakh to Shrawan in Doti, they were grazed from Asar to Mangsir in Kavre. About 83% of farmers in Panchthar grazed their animals from Baishakh to Kartik and the rest 17% year round. These differences could be associated mainly with the cropping and livestock production systems as practiced in the respective area. It is also notable that* ***only about 50% of available fodder in the LHF and 45% in the community forests were utilized for livestock feeding****.*

Figure 1: Number Days Fodder and Litter Collection and Collection per HH per Year, kg



d) *When discussed with the leasehold forest members about the livestock feed composition by source, it was learned that grazing in the forest or communal lands constituted about 55% of the total feed followed by crop fields (weeds) (17.8%), fodder collected from forest (14.7%) and crop residues (12.8%) (Figure 2). For CFUG members grazing contributed the least (12%), followed by crop residues (25%), and crop field residues (weeds) and forest fodder each contributing nearly one-third of the total feed. These data indicate that forests contribute about 43% of livestock feed of (about 30% HH) CFUG members and about 70% of livestock feeds of (about 80% HH) LFUG members. These figures could be interpreted as community forests contribute only 13% of livestock feed of the CFUG members and 56% of LFUG members in the mid hills.*

A Glimpse of Fodder Supply from Community and Leasehold Forests



3.4.2 Available TDN by crop

37. Total TDN available from crop and milling by-products in the country is estimated at 4.44 million MT (Table 6). Paddy straw contributes about half of the total TDN supplied from different crops, followed by maize and wheat. Each of other crops contributes less than 5% of total TDN supply. While millet and most legumes except soybean contribute 100% of TDN from straws, straws from most other crops contribute above 50%. On average, straws contribute 65% of TDN supply. However, when considered paddy, wheat and maize crops together, their contribution of straw amounts about 86%, meaning that these are the major crops to contribute to meeting livestock TDN. This figure is much higher than reported by Shah et., al (2016), as the authors had reported that straw contributed 50% of total dry matter of buffalo diet in Chitwan, Gorkha and Tanahu districts. This difference could be associated with the differences in the type of animals considered, cropping systems and the season of study. Moreover, while Shah et.al.. assessed feeding management of milking animals during the winter season, we considered the complete national herds considering a complete calendar year. Milking animals are certainly fed better than other stocks in the herds.

Table 6: TDN Available by Crop and Share of Straw

SN	Crops	Total TDN, MT	TDN share by Straw, MT	TDN share by crop (%)	TDN share of straws to total available TDN (%)
1	Paddy	2,099,420	1,643,858	51.01%	78.3%
2	Maize	908,778	721,088	22.38%	79.3%
3	Wheat	849,158	423,633	13.15%	49.9%
4	Sugarcane	153,694	145,562	4.52%	94.7%
5	Millet	127,589	127,589	3.96%	100.0%
6	Lentil	98,411	65,158	2.02%	66.2%
7	Mustard	84,967	25,235	0.78%	29.7%
8	Other legumes	14,375	14,375	0.45%	100.0%
9	Barley	10,638	9,013	0.28%	84.7%
10	Black gram	8,553	8,553	0.27%	100.0%
11	Soybean	24,844	5,562	0.17%	22.4%
12	Pigeon pea	8,516	4,703	0.15%	55.2%
13	Sunflower	11,713	4,405	0.14%	37.6%
14	Buckwheat	5,736	4,298	0.13%	74.9%
15	Linseed	10,811	3,838	0.12%	35.5%
16	Groundnut	3,327	3,327	0.10%	100.0%
17	Grass pea	3,713	2,488	0.08%	67.0%

SN	Crops	Total TDN, MT	TDN share by Straw, MT	TDN share by crop (%)	TDN share of straws to total available TDN (%)
18	Chickpea	4,088	2,322	0.07%	56.8%
19	Sesame	3,739	2,137	0.07%	57.1%
20	Horse gram	1,945	1,945	0.06%	100.0%
21	Sarson	5,992	1,780	0.06%	29.7%
22	Niger	1,849	915	0.03%	49.5%
23	Rayo	1,785	530	0.02%	29.7%
	Overall	4,443,642	3,222,316	100.0%	65.1%

Source: Derived from Statistical Information on Nepalese Agriculture (2016/17) and expert consultation for conversion factor from grain to crop residues and milling by-products.

38. In addition, there are few things to be noted here. Firstly, green forage constitutes the major feed of livestock during the rainy season. In many cases, the fodder is at surplus during this season. There is little effort to conserve this surplus. On the other hand, straw makes up the major livestock diet during the winter and the summer. This means that the animals are over supplied with green feed during the rainy season (though not in terms of balanced nutrition) and undersupplied during the winter and summer. During the later periods, the animals are in very poor nutritional condition, which compels them to under perform. Because, the inclusion of rice straw beyond 25% in dairy animal ration and 50% in the dry cow ration limits intake and hence animal production performance[3]. Secondly, almost all of the sugarcane bagasse are used as fuel in sugar and paper industries, and are the major sources of fuel even during jaggery (gur) making in the rural Nepal. Thirdly, most of molasses is used for spirit manufacturing. Molasses is not the choice of the feed industries as they are usually stored in open pits and are adulterated with soil, sand and water, if not with other stuffs like saw dust. Fourthly, in the terai about 30% of straw (wheat and rice) are burnt in the fields due to the use of combine harvester. It should, therefore, be noted that the output of straw biomass per unit crop harvested might decline in future due to increasing use of harvesters. Finally, there is increasing use of rice straw by the growing mushroom industries.

3.4.3 Available TDN from Improved Forage and Pasture

39. Total area covered under improved forage and pasture and total TDN production in the country is given in Table 7. Total estimated TDN production is about 694,749 MT. This is equivalent to about 7% of total TDN supplied by different sources (Table 5 above). However, the estimates were based on scattered data for dry matter and book values for TDN.

40. The production and TDN values for broom grass were based on Indian literatures. The table below indicates that the DM yields of most fodder crops are reported much below than Indian reports. For example, the Indian and Pakistani scientists reported the DM yield of napier at 80 MT/ha; Oat[4] 14 MT/ha; berseem[5] 10 to 12 MT/ha and so on (http://agritech.tnau.ac.in/expert system/cattle buffalo/Fodder %20Production.html). Nepal also has potential to produce these fodders with yields at par to India and Pakistan. What is required is the enthusiasm and commitment to strive to develop technologies that are at least at par to Indian or Pakistani technologies. Given the small landholdings in Nepal, concerted effort in this direction is inevitable.

[3] Daniel. J. Drake. Glenn Nader and Larry Forero (2002). Feeding Rice Straw to Cattle. ANR Publication 8079. University of California.

[4] Muhammad Saleem et.al (2015). Yield and Quality of Forage Oat (Avena sativa L.) Cultivars as Affected by Seed Inoculation with Nitrogenous Strains. American Journal of Plant Sciences. Vol.06 No.19, Article ID:62161.

5 Indian Agro-net.com. Cultivation of Fodder Crops - Agriculture.

Table 7: 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

4. Estimated Feed (TDN) Demand

41. Total TDN demand of livestock in 2016/17 is estimated at 12.257 million MT (Table 8). 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 8: 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: Author's estimate

5. Feed (TDN) Balance

5.1 Feed Balance at National Level

42. The above analyses (Table 5&8 above) could be summarized in the form of feed balance sheet as given in Table 9. 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 9: Feed (TDN) Balance

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

43. 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.

44. Maize constituted more than 50% of total import. The feed industries imported about 75% of their needs for yellow maize. The main reason was the poor quality of grain maize (aflatoxin infested?) produced locally in the rainy season when farmers are busy with rice planting, and lack maize drying and storage facilities. Support to farmers to operate grain drying and storage facilities at local level could solve this problem to a great extent.

5.2 Feed Balance by Ecological Belts

5.2.1 Available TDN by Sources

45. While crop and milling by-products were the dominant sources of feeds in the terai and mid-hills, forest and grasslands had dominant role in livestock feed supply in the high hills (Table 10). Forests were important in both mid and high hills. Contribution of improved forage was higher in Terai than in mid hills or high hills. Of the total available TDN, the contribution of high hills was just about 10%. The mid hills and high hills each shared about 45% of total TDN available in the country.

Table 10: Available TDN by Source and Eco-zone

Sources of Feeds	High hills		Mid hills		Terai		Total
	Available TDN. MT	Percent Share	Available TDN. MT	Percent Share	Available TDN. MT	Percent Share	
Forest	295,981	28.4%	1,249,404	27.5%	524,949	11.6%	2,070,334
Shrub land	64,365	6.2%	92,561	2.0%	20,095	0.4%	177,021
Grassland	146,658	14.1%	39,733	0.9%	69,136	1.5%	255,528
Cultivated fields	145,441	13.9%	734,121	16.2%	647,229	14.3%	1,526,792
Barren lands	63,077	6.0%	26,352	0.6%	2,652	0.1%	92,081
Crop and milling by-products	220,195	21.1%	1,766,423	38.9%	2,457,026	54.3%	4,443,645
Improved forage and pasture	31,398	3.0%	252,724	5.6%	410,626	9.1%	694,749

Sources of Feeds	High hills		Mid hills		Terai		Total
	Available TDN. MT	Percent Share	Available TDN. MT	Percent Share	Available TDN. MT	Percent Share	
Commercial marketing of silage @40 MT/day, 70% TDN		0.0%		0.0%	4,380	0.1%	4,380
Kitchen wastes	28,767	2.8%	171,590	3.8%	185,295	4.1%	385,653
Grain supplementation @5% of total TDN requirement in general	46,906	4.5%	204,080	4.5%	203,536	4.5%	454,522
Total	1,042,789	100.0%	4,536,989	100.0%	4,524,925	100.0%	10,104,705
TDN supply (%) by eco-zone (of national supply)		10.03%		44.9%		44.8%	

Source: Author's estimate

5.2.2 TDN Requirements by Eco-zone

46. TDN requirement in the mid hills was the highest (47.6%) followed by the terai (43.6%) and the high hills (8.8%) (Table 11a). Cattle population was the major consumer of feeds across the eco-zone, followed by buffalo and milk production. While the TDN demand for cattle population was 46% in the high hills, it was 39% in the terai and 37.7% in the mid hills (Table 11b).

Table 11a: TDN Requirement by Eco-Zone

Species	TDN Requirement, MT			Total
	High hills	Mid hills	Terai	
Cattle	493,385	2,201,262	2,086,008	4,780,656
Buffalo	182,138	1,423,380	1,199,274	2,804,792
Yak/Nak	45,816	8,339	-	54,154
Milk production	152,380	1,224,432	1,119,354	2,496,166
Goat	81,233	398,935	273,160	753,328
Sheep	20,239	21,286	8,588	50,113
Horse	36,695	33,775	4,947	75,417
Pig	49,770	315,087	220,127	584,984
Poultry	11,467	204,657	335,405	551,529
Duck	243	2,328	5,446	8,018
Fish	46	2,113	95,566	97,725
Total	**1,073,414**	**5,835,593**	**5,347,875**	**12,256,882**
Share for TDN requirement by Eco-zone	8.8%	47.6%	43.6%	100.0%

Source: Author's estimate

Table 11b: TDN Requirement by Eco-Zone

Species	High hills	Mid hills	Terai	Average
Cattle	46.0%	37.7%	39.0%	40.9%
Buffalo	17.0%	24.4%	22.4%	21.3%
Yak/Nak	4.3%	0.1%	0.0%	1.5%
Milk production	14.2%	21.0%	20.9%	18.7%
Goat	7.6%	6.8%	5.1%	6.5%
Sheep	1.9%	0.4%	0.2%	0.8%

Species	High hills	Mid hills	Terai	Average
Horse	3.4%	0.6%	0.1%	1.4%
Pig	4.6%	5.4%	4.1%	4.7%
Poultry	1.1%	3.5%	6.3%	3.6%
Duck	0.0%	0.0%	0.1%	0.1%
Fish	0.0%	0.0%	1.8%	0.6%
Total	**100.0%**	**100.0%**	**100.0%**	100.0%

Source: Author's estimate

5.2.3 The Feed Balance by Eco-zone

47. Table 10&11a could be summarized as below in Table 12. The feed deficit is highest in the Mid Hills (-22.25%), followed by Terai (-15.39%). The feed situation in the high hills is more or less balanced, although the estimate shows a deficit of -2.85%. These findings are lower than reported by Maharjan (2003), who reported that the feed deficit is about 15% in the high hills, 40% in the mid hills and 19% in the terai.

48. It should also be noted that feed deficit prevails in all eco-zone particularly during the winter. Straw in the terai and the mid hills, and straw and dry grass in the high hills make up most of feeds during this season.

Table 12: Feed Balance by Eco-Zone

Feed Balance	High hills	Mid Hills	Terai	Total
TDN Available, MT	1,042,789	4,536,989	4,524,925	10,104,703
TDN Demand, MT	1,073,414	5,835,593	5,347,875	12,256,882
Feed Demand Supply Balance	(30,625)	(1,298,604)	(822,950)	(2,152,179)
Percent Feed Deficit	**-2.85%**	**-22.25%**	**-15.39%**	**-17.56%**

5.3 Feed Balance by Province

5.3.1 TDN Available by Province

49. An attempt was made to assess the feed balance by province also. It was observed that TDN available (of total national supply) by province ranged from 9.3% in Province 6 to 19% in Province 1. Province 2 &3 each had TDN share of about 15%, and Province 4&7 each of about 12% (Table 13a).

50. The crop and milling by-products remained dominant TDN contributors across the province, the contribution ranging from 25.8% in Province 6 to 58.6% in Province 2 (Table 13b). Forest was the second dominant source of feeds in Province 6&7 contributing about 30% of total TDN supply in each province. Its contribution in province 2 was only 6.5%. The third source was the cultivated fields offering green feeds from crop weeding. In Province 6, both grasslands and shrub lands were important sources of livestock feeds.

Table 13 (a): TDN available by Province

Source of Feeds	Province							
	1	2	3	4	5	6	7	Total
Forest	376,445	100,770	366,369	243,245	350,816	279,021	353,668	2,070,334
Shrub land	32,039	5,726	10,984	39,506	17,933	44,611	26,222	177,021
Grassland	21,044	25,079	15,862	50,965	28,260	89,067	25,252	255,528
Cultivated fields	290,072	230,600	207,042	156,747	303,915	154,068	184,349	1,526,792
Barren lands	13,092	866	9,757	19,552	4,216	32,096	12,503	92,081
Crop and milling by-products	897,227	908,705	582,749	463,611	875,359	242,055	473,935	4,443,642

Source of Feeds	Province							
	1	2	3	4	5	6	7	Total
Improved forage and pasture	134,289	136,266	176,925	110,527	75,250	29,010	32,480	694,749
Commercial marketing of silage @40 MT/day, 70% TDN		4,380						4,380
Kitchen wastes	71,670	69,822	82,880	38,261	62,427	24,566	36,026	385,652
Grain supplementation @5% of total TDN requirement	86,286	69,664	68,271	53,720	80,754	42,041	53,788	454,525
Total	1,922,165	1,551,878	1,520,839	1,176,134	1,798,931	936,534	1,198,224	10,104,703
Percent share of province	19.0%	15.4%	15.1%	11.6%	17.8%	9.3%	11.9%	

Source: Author's estimate

Table 13 (b): TDN Available by sources

Source of Feeds	Province						
	1	2	3	4	5	6	7
Forest	19.6%	6.5%	24.1%	20.7%	19.5%	29.8%	29.5%
Shrub land	1.7%	0.4%	0.7%	3.4%	1.0%	4.8%	2.2%
Grassland	1.1%	1.6%	1.0%	4.3%	1.6%	9.5%	2.1%
Cultivated fields	15.1%	14.9%	13.6%	13.3%	16.9%	16.5%	15.4%
Barren lands	0.7%	0.1%	0.6%	1.7%	0.2%	3.4%	1.0%
Crop and milling by-products	46.7%	58.6%	38.3%	39.4%	48.7%	25.8%	39.6%
Improved forage and pasture	7.0%	8.8%	11.6%	9.4%	4.2%	3.1%	2.7%
Commercial marketing of silage @40 MT/day, 70% TDN	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Kitchen wastes	3.7%	4.5%	5.4%	3.3%	3.5%	2.6%	3.0%
Grain supplementation @5% of total TDN requirement (excluding commercial poultry and fish)	4.5%	4.5%	4.5%	4.6%	4.5%	4.5%	4.5%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Author's estimate

5.3.2 TDN Requirements by Livestock Species and by Province

51. The TDN demand by livestock species including milk production is given in Table 14a. Cattle and buffalo remained the major species taking about 62% of total TDN demand (Table 14b). Cattle alone had TDN demand of over 45% of total demand in Province 1, 6 and 7. TDN demand for buffalo was more in Province 4&5 compared to other provinces. TDN Demand for milk production was also the highest in Province 4. Similarly, the TDN demand for pig was the highest in Province 1 and the TDN highest for poultry in Province 3.

Table 14a: TDN Requirements by Species and by Province

Species	Province							
	1	2	3	4	5	6	7	Total
Cattle	1,279,643	680,529	732,924	345,424	696,709	399,523	645,904	4,780,656
Buffalo	466,233	424,041	495,795	364,739	605,398	166,392	282,193	2,804,792
Yak/Nak	17,166	-	8,935	11,895	-	15,238	921	54,154
Milk production	496,092	357,302	470,155	338,431	441,358	123,055	269,772	2,496,166
Goat	155,990	96,608	145,607	78,419	134,356	68,750	73,599	753,328
Sheep	4,810	429	4,585	6,585	8,911	18,373	6,420	50,113
Horse	8,138	335	1,351	5,549	5,263	49,219	5,563	75,417
Pig	258,269	43,939	81,870	41,904	102,023	29,575	27,404	584,984
Poultry	37,898	56,699	308,889	59,357	71,486	6,016	11,184	551,529
Duck	2,156	1,971	1,015	1,114	1,270	213	278	8,018
Fish	12,375	55,311	5,373	591	21,548	119	2,409	97,725
Total	2,738,769	1,717,163	2,256,500	1,254,010	2,088,321	876,471	1,325,647	12,256,882
	22.3%	14.0%	18.4%	10.2%	17.0%	7.2%	10.8%	100.0%

Source: Author's estimate

Table 14b: Percent Share of Livestock in TDN Demand

Species	Province							
	1	2	3	4	5	6	7	Average
Cattle	46.7%	39.6%	32.5%	27.5%	33.4%	45.6%	48.7%	39.1%
Buffalo	17.0%	24.7%	22.0%	29.1%	29.0%	19.0%	21.3%	23.1%
Yak/Nak	0.6%	0.0%	0.4%	0.9%	0.0%	1.7%	0.1%	0.5%
Milk Production	18.1%	20.8%	20.8%	27.0%	21.1%	14.0%	20.4%	20.3%
Goat	5.7%	5.6%	6.5%	6.3%	6.4%	7.8%	5.6%	6.3%
Sheep	0.2%	0.0%	0.2%	0.5%	0.4%	2.1%	0.5%	0.6%
Horse	0.3%	0.0%	0.1%	0.4%	0.3%	5.6%	0.4%	1.0%
Pig	9.4%	2.6%	3.6%	3.3%	4.9%	3.4%	2.1%	4.2%
Poultry	1.4%	3.3%	13.7%	4.7%	3.4%	0.7%	0.8%	4.0%
Duck	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
Fish	0.5%	3.2%	0.2%	0.0%	1.0%	0.0%	0.2%	0.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Author's estimate

5.3.3 Feed Balance by Province

52. The above analyses indicated that the Province 3 and 1 were at severe feed deficit situation (32.6% and 29.82% respectively) compared to other provinces (Table 15). Province 6 seemed at positive balance (+6.85%). The deficit in other provinces ranged from -6.21% in Province 4 to -13.86% in Province 5. Province 2 and 7 had deficit of about 9 to 10%.

Table 15: Feed Balance by Province

Feed Balance	1	2	3	4	5	6	7	Total
Available TDN, MT	1,922,165	1,551,878	1,520,839	1,176,134	1,798,931	936,534	1,198,224	10,104,703
TDN Demand, MT	2,738,769	1,717,163	2,256,500	1,254,010	2,088,321	876,471	1,325,647	12,256,882

Feed Demand Supply Balance	(816,605)	(165,285)	(735,661)	(77,876)	(289,390)	60,063	(127,423)	(2,152,179)
Percent Feed Deficit	-29.82%	-9.63%	-32.60%	-6.21%	-13.86%	6.85%	-9.61%	-17.56%

6. The Future Feed Balance

53. The future feed balance will depend on growth of animal population, increase in milk production in the demand side and increase in crop production (crop residues and milling by-products), access to and productivity of forests and grazing lands and the progress of livestock sector development agencies in improved forage production in the supply side. While, the feed supply from forest and grazing lands could be assumed to be constant, the rural households (supply source for kitchen wastes) is estimated to reduce by 20% at 5 years of intervals and supply of grain supplements will depend on changes in herd composition. With these qualifications, the next ten years feed balance sheet has ben developed.

6.1 Livestock Population in the Next 10 Years

54. The animal population of 2006/7, 2009/10, 2013/14 and 2016/17 were used as the reference years for future changes in livestock population and milk production. The populations of yak/chauries and equines are taken as constant, since their number have not changed much for the last few decades. As shown in Table 16a, the compound annual growth rate of fish will be the highest (9.45%), followed by poultry (8.72%), goats (6.96%), buffalo (6.11%) and pig (5.97%) in the next ten years. The sheep and duck populations are expected to decline 2.22% (-) and 1.68% (-) respectively.

55. Significant growth (7%) growth in milk production is expected in the next ten years. When taken 1996/97, 2001/02, 2005/06, 2009/10, 2013.14 and 20116/17 as reference years the annual compound growth rate will be 6.8% for cattle milk and 6.7 % for buffalo milk (Table 16b).

Table 16a: Livestock Population Projection for the Next 10 Years

Species	1996/97	2016/17	2021/22	2026/27	Annual compound growth rate (%)
Cattle	7,048,660	7,347,487	7,669,569	8,024,735	0.89%
Buffalo	3,419,150	5,177,998	7,389,659	9,369,600	6.11%
Yak/Chauries	60,000	69,346	69,346	69,346	0.00%
Equines	NA	68,712	68,713	68,714	0.00%
Sheep	869,142	801,975	712,052	640,752	-2.22%
Goats	6,080,060	11,165,099	16,491,013	21,888,424	6.96%
Pigs	765,718	1,328,036	1,840,411	2,372,115	5.97%
Fowl	16,664,730	70,007,151	110,763,488	161,581,436	8.72%
Duck	416,943	394,775	358,876	333,323	-1.68%
Milking cows	826,320	1,029,529	1,272,140	1,498,828	3.83%
Milking buffaloes	882,140	1,509,512	2,128,883	2,766,707	6.25%
Fish production, MT	11,727	56,675	87,459	139,802	9.45%

Source: Derived from MoALD annual reports (statistical information on agriculture).

Table 16b: Milk Production Projection for the Next 10 Years

Category	Projected Milk Production, MT				
	1996/97	2016/17	2021/22	2026/27	Compound annual growth rate (10 years)
Cow milk	310,183	665,285	951,385	1,288,511	6.8%
Buffalo milk	701,980	1,245,954	1,830,977	2,394,282	6.7%

Source: Derived from MoALD annual reports (statistical information on agriculture).

6.2 TDN Requirement Projections for the Next 10 Years

56. The growth in TDN demand will grow by 9.4% for fish followed by 8.9% for poultry, 7.1% for goat and 6.2% for buffalo production (Table 17). The demand for sheep and duck will be negative. Overall, the TDN requirement for livestock will reach 1.27 times in 2021/22 and 1.54 times in 2026/27 compared to the requirement for the base year (2016/17).

Table 17: TDN Requirements Projection for the Next 10 Years

Species	2016/17	2021/22	2026/27	Annual compound growth rate (%)
	TDN requirement, MT	TDN requirement, MT	TDN requirement, MT	
Cattle	4,780,656	5,020,750	5,253,252	0.9%
Buffalo	2,804,792	4,009,909	5,084,300	6.1%
Sheep	50,113	44,568	40,105	-2.2%
Goat	753,328	1,130,804	1,500,910	7.1%
Pig	584,984	833,737	1,074,608	6.3%
Yak/Nak	54,154	54,154	54,154	0.0%
Equine	75,417	75,417	75,417	0.0%
Fowl	551,529	890,116	1,298,499	8.9%
Duck	8,018	7,335	6,813	-1.6%
Cow milk, MT	801,668	990,583	1,167,100	3.8%
Buffalo milk, MT	1,694,497	2,389,770	3,105,757	6.2%
Fish, MT	97,725	150,806	241,061	9.4%
Total	**12,256,882**	**15,597,950**	**18,901,976**	**3.8%**
Increase in TDN Demand		**1.27**	**1.54**	

6.3 Projected Growth in TDN Supply from Crops

57. If the growth during 2006/07 to 2016/17 will be maintained, the growth in TDN supply from crops will average at about 7% per annum (Table 18). The highest growth will be observed in oilseed crops (11%), followed by paddy (9.5%), maize (7.4%) and wheat (7.1%). This means that paddy, maize and wheat will remain the major contributors to livestock feed supply also in future.

Table 18: TDN Supply Growth Associated with Advances in Crop Production

Major crop	Total TDN factor	2016/17	2021/22	2026/27	Compound annual growth rate of TDN supply
Paddy, MT	0.415	2,169,683	3,777,258	5,384,184	9.5%
Maize	0.395	908,778	1,384,079	1,858,393	7.4%
Millet	0.416	127,589	151,317	174,083	3.2%
Wheat	0.452	849,157	1,267,748	1,679,011	7.1%

Major crop	Total TDN factor	2016/17	2021/22	2026/27	Compound annual growth rate of TDN supply
Barley	0.349	10,638	12,668	14,601	3.2%
Oilseed	0.532	114,088	219,080	323,872	11.0%
	Total	**4,179,932**	**6,812,150**	**9,434,144**	6.9%

6.4 Projected TDN Supply from Forests, Grasslands and Shrub Lands

58. It is uncertain on the land use pattern of the country in future. Neither can we predict if there will be any significant interventions in the near future on these lands for increased forage supply. In fact accessibility to forests may even decrease due to closing of community and leasehold forests for animal grazing or restriction on fodder collection. Therefore, for the present purpose of estimating the gaps and defining forage interventions, we assumed that the TDN supply from forest resources will remain constant.

6.5 TDN Supply from Farmlands and Barren Lands

59. TDN supply from farmlands and barren lands is also presumed constant with assumption that the area will remain the same and no significant increase in weed fodder will happen due to increased crop yields. Future studies may include any changes that will occur in these resources. In addition, the TDN from improved forages is kept constant to base year 2016/17 to estimate the additional areas that need to be brought under fodder production in the future.

6.6 Overall TDN supply projection

60. With the above assumptions, the total supply of TDN from various sources has been estimated (Table 19). The total TDN supply is expected to reach 12,865,507 MT in 2026/27 from 10,104,703 MT in 2016/17. This corresponds to 1.54 times more than the TDN supply in the base year 2016/17.

Table 19: TDN Supply Projection by Source

Sources of feed	Available TDN, MT		
	2016/17	2021/22	2026/27
Forest	2,070,334	2,070,334	2,070,334
Shrub land	177,021	177,021	177,021
Grassland	255,528	255,528	255,528
Crop and milling by-products	4,443,642	6,812,150	9,434,144
Farm forages (weeds) etc.	1,526,792	1,526,792	1,526,792
Improved forage and pasture	694,749	694,749	694,749
Commercial silage	4,380	7,008	11,914
Barren area	92,081	92,081	92,081
Kitchen wastes*	359,000	287,200	57,440
Grain supplementation @2.5% of total TDN requirement in general	481,176	275,456	321,148
Total	**10,104,703**	**11,221,901**	**12,865,507**

6.7 Expected Feed Balance under No Forage Intervention Scenario

61. If additional forage intervention does not take place either in the form of expanded forage area, introduction of high yielding forage crops or adoption of double or triple cropping, the feed deficit will reach 28% in 2021/22 and 32% in 2026/27 (Table 20). However, interpretation of this data requires caution: (a) It is not certain if the crop and milling by-

products will grow as expected even if the crop production will grow as expected (Table 18 above); (b) there is high possibility that many local animals would be replaced by improved stocks along with reduction in local animal population if DLS extension reaches out new production pockets. This may reduce the maintenance cost of animals balancing almost the cost of milk/meat production; (c) It is likely that more and more land will be utilized for silage crop growing having positive impact on feed balance; and (d) given the right option, many farmers will be adopting at least double cropping system to address the feed problem.

Table 20: TDN Balance by Year

Details	2016/17	2021/22	2026/27
TDN Available, MT	10,104,703	11,221,901	12,865,507
TDN Requirement, MT	12,256,882	15,597,950	18,901,976
Net deficit	(2,152,179)	(4,376,049)	(6,036,469)
Percent deficit	-17.56%	-28.06%	-31.94%

6.8 Feed Deficit When Considered only Grazing Animals

62. When the requirements of only the grazing animals are considered, the feed deficit was only 8.26% (-), which swelled to 18.18% (-) for 2021/22 and 20.98% (-) for 2026/27 (Table 21). This indicates that the livestock in Nepal are not in bad shape as people guessed, when considered the TDN balance. Paradoxically, however they suffer from over-supply during the rainy season and critically under-supply during the winter and the dry summer. To balance their nutrition, it is imperative that actions are taken to utilize the surplus fodder of the rainy season and increase flow of green forage during the winter and the dry summer.

Table 21: Feed Balance when Considered only Grazing Animals

Details	2016/17	2021/22	2026/27
TDN available, MT	10,104,703	11,221,901	12,865,507
TDN Requirement, MT	11,014,626	13,715,955	16,280,996
Net deficit	(909,923)	(2,494,054)	(3,415,489)
Percent deficit	-8.26%	-18.18%	-20.98%

7. Options for Addressing TDN Deficit

63. To address the above issue, we need to identify appropriate fodder species that is high yielding and high in nutrient contents. At the same time, given the small land holding, we should be promoting double or triple cropping system so as to increase TDN output per unit area. Based on data from Table 23 below, some fodder production options are given in Table 22. These options show that selection of crops will determine the area to be covered per year to meet the required TDN.

64. The cropping system below indicates that if we promote option 1, each year we need to bring 25,276ha of new land under fodder cultivation. But if we chose option 3, we need to bring 84,156ha of new lands per year under fodder cultivation. There could be several other options also, which need to be tested and field verified.

65. To address the land shortage issue, we should be facilitating promotion of land leasing system. For this, farmers may need support for irrigation, power and mechanization. DLS should prepare itself for these supports. In addition, DLS should learn lessons from the past that fodder promotion in goat areas is less successful than in dairy pockets. The priority targets for fodder development should be the terai and the river basins of the hills for larger impacts. In the hills where there is water shortage, we should be looking at drought resistant species or varieties.

Table 22: Options for Fodder Production and New Land (area) to be covered by Year

Potential crops	Potential DM yield, MT/ha	TDN MT per ha	Additional area (ha) to be brought under fodder production			Cumulative area, ha	Hectare to be covered per year
			2016/17	2021/22	2026/17		
1. Napier+ centro/siratro - Berseem	46	26.98	33,726	92,441	126,593	252,760	25,276
2. Napier +centro/sirator - Oat+vetch	47	27.75	32,790	89,876	123,081	245,747	24,575
3. Maize+cowpea - Berseem - Maize+cowpea	12.3	8.1	112,290	307,781	421,492	841,563	84,156
4. Maize+cowpea - Oat - Maize+cowpea	13	8.62	105,600	289,445	396,382	791,427	79,143
5. Teosinte+cowpea - Berseem- Teosinte+cowpea	15.33	9.66	94,195	258,184	353,570	705,949	70,595
6. Teosinte+cowpea - Oat+vetch- Teosinte+cowpea	16	10.2	89,442	245,156	335,730	670,328	67,033

Table 23: Potential Forage Crops and their Productivity

Potential crops	DM yield, MT/ha	TDN content (percent)	TDN MT per ha	Percent land cover	TDN supply MT/year	New land to be covered per year to 2025/26
Napier (Packchong, super napier) (1)	80	58%	29.0	60%	407,720	14,059
Multicut shorghum (2)	30	57%	17.1	20%	135,907	7,948
Lucerne (3)	19	64%	12.2	5%	33,977	2,794
Teosinte (4)	17	63%	10.7	5%	33,977	3,172
Fodder Maize (5)	12.5	67%	8.4	5%	33,977	4,057
Berseem (6)	12	63%	7.6	2%	13,591	1,798
Oat (7)	14	65%	6.5	3%	20,386	3,136
				Total	679,533	36,965

Sources:

(1) http://indiaeng.com/Kaveripakkam/01-hybrid_napier_grass.htm. Hybrid Napier Grass (CO-4, CO-3).
(2) D.C. Roy and N. K. Tudu (2013). On Farm Evaluation of Yield and Quality of Multicut Sorghum (Sorghum bicolor) Fodder Through Application of Phosphorus. International Journal of Science and Research (IJSR). ISSN (Online): 2319-7064.
(3) www.dairyknowledge.in/sites/default/files/dkp-overview-of-fodder_akgarg.pdf
(4) Devkota et.al (2017). J. Agri. and Forestry University, Volume 1.
(5) ICAR. Fodder Production.
(6) http://eagri.org/eagri50/AGRO301/pdf/lec28.pdf (India)
(7) www.dairyknowledge.in/sites/default/files/dkp-overview-of-fodder_akgarg.pdf

8. Seed Demand

66. Annual seed demand will depend upon the type of fodder cultivation system we choose. Based on the need to bring new lands under fodder cultivation each year under different

cropping options and the area required under each option (please refer Table 22 above), the seed demand is estimated in Table 24 below. If napier is taken as annual crop, the seed demand would be the minimum (885 MT of seeds of berseem and siratro or centro) compared to other cropping options. Depending upon the option, the seed demand under the regime may be as high as 15,116 MT per year. At the moment national seed supply is 1,315 MT, which is almost ten times less than the requirements estimated. In such situation, a comfortable strategy for DLS will be promoting annual fodder species such as berseem, oat, cowpea, vetch, maize and Teosinte. It is also important to note that such intensive production system can be promoted in the terai and the river basins of the mid hills, and not in the mid hills in general. Most of the lands in the mid hills (except river basins) lack water sources for irrigation. Therefore, in these areas, effort should be laid on developing fodder tree blocks for promoting goat production.

Table 24: Estimates for Annual Seed Demand

Potential crops	Napier sets ('million)	Seed required per year, MT							
		Centro/ Siratro	Berseem	Oat	Vetch	Maize	Teosinte	Cowpea	Total seed
1. Napier+ centro/siratro - Berseem	253	253	632						885
2. Napier +centro/sirator - Oat+vetch	246	246		2,212	737				3,195
3. Maize+ cowpea - Berseem - Maize+cowpea			2,104			4,713		1,262	8,079
4. Maize+ cowpea - Oat+vetch - Maize+cowpea				7,123	2,374	4,432		1,187	15,116
5. Teosinte+ cowpea - Berseem- Teosinte+cowpea			1,765				4,236	882	6,883
6. Teosinte+ cowpea - Oat+vetch- Teosinte+cowpea				6,033	2,011		4,022	838	12,904

Assumed seed rate:
(a) Centro/siratro - 10kg/ha; (b) Oat +vetch - 90kg+30kg/ha; (c) Berseem - 25kg/ha; (d) Maize+cowpea - 28kg+7.5kg/ha; (e) Teosinte+cowpea - 30kg+6.25kg; and (f) napier at 10,000 sets her ha.

9. Conclusions and Recommendations

67. The above findings and discussions indicate that livestock are under-fed across the eco-zones and across the provinces except Province 6. Over all deficit stands at 17.56% (-) of total TDN requirement. By ecological belts, high hills seemed pretty well off in terms of TDN availability for livestock and the mid hills at high feed pressure. Similarly, while Province 6 is at positive balance, Province 1 &3 are at severe feed stress. When only the grazing animals are taken into account, feed deficit stands only at 8.26% (-). However, straw, on average, constitutes over 65% of total TDN supply. When considered paddy and maize, their TDN contribution from straw reaches about 80% of total TDN supply from their part. These figures indicate that the livestock feeds in Nepal are highly imbalanced. Livestock are over supplied with greens during the rainy season and under supplied during the winter and the dry summer, irrespective of quality though. Based on these observations, the following actions are recommended to meet livestock nutrition in a balanced way:

a) **DLS should focus on on-farm forage production:** In the past when forest was the major source of feeds to livestock, DLS along with the Department of Forest worked on developing feed base in the leasehold and the community forests. However, the situation has changed now. There is declining forest grazing due to (a) increasing predatory habitats and declining ground forage in the forests due to increasing tree canopy closure; and (b) declining farmers' interest to take their animals to the forest grazing due to migration of youth for remittance. Therefore, DLS efforts should be to develop on-farm forage base rather than depending on forests.

b) **Pasture development in the high hills should be accompanied with investment projects in the livestock sector:** In the absence of robust livestock sector investment projects, pasture development in the high hills will not be effective. Distribution of improved seeds alone will have little or no impact. On the other hand, the high hills keep the highest potential for livestock production in the country due to its endowment with large tracks of rangelands. The carrying capacity of these rangelands could be further enhanced through application of appropriate management practices. For example, Grela (1990) reported that white clover could produce up to 9.5 MT/ha (≈7.6 MT TDN/ha) under good management system. Similarly, Pasture and Fodder Research Station Rasuwa reported that DM production from cocksfoot and rye grass averaged 4.79 DM MT/ha (≈2.77 MT TDN/ha) and 4.58 MT DM/ha (≈3.2 MT TDN/ha) respectively in 2015/16. However, the average TDN yields from the natural grasslands averages only 0.68 MT TDN/ha (LRMP, 1986). Therefore, it is possible to increase the pasture yields in the high hills significantly. However, the pasture development programs in the high hills should be coupled with an implementation of livestock sector investment projects.

c) **Need to prioritize the fodder and pasture crops:** There is a long array of forage crops being promoted in the country. Giving equal emphasis to all crops takes away not only the scarce resources but also produces no or little outputs and impacts. Also to be noted is that tropical or sub-tropical pasture species such as molasses grass should not get priority any more for its low value in livestock feeding. The priority crops could be the selected silage making crops and winter growing crops with high productivity and high nutritional value.

d) **Promote double or triple fodder cropping**: To date the common practice is to produce napier and sudan grass in the summer/rainy season and oat or berseem in the winter under single cropping system. Given the small landholding and shortage of feeds particularly during the winter and dry summer, there is a need of promoting double or triple fodder cropping system for doubling or tripling the nutrient production per unit of land area. NARC and DLS should be working together for identifying crops and developing cropping system for the hills and the terai. It is also important that the non-legume fodder crops such as napier, mulato, maize, teosinte, oat etc. are mixed with legumes such as cowpea, winter vetch, lablab beans etc.

e) **Promote land leasing system:** Land is the limiting factor for fodder production balanced feeding of commercial herds. Therefore, the DLS should facilitate land leasing system for feed development. This could be achieved by working with the dairy farmers, their organizations and the local municipality through awareness raising on the value of balanced feeding e.g., (a) the value of green forage; and (b) limitations on the use of straws to dairy animals.

f) **Implement massive forage production program in partnership with the silage making company and district forage development federations.** Winter and summer months are the most critical period when the animals depend mainly on straws. Making silage at individual level may not be economical due to small farm sizes. Therefore, the DLS should support the private sector to develop feed marketing chains with emphasis

on silage production and marketing. While the silage making company would be important for taking responsibility of procurement of fodder from farmers and processing into silage, the district forage development federations or dairy cooperatives can take responsibility of extension and marketing of silage. The government's role will be to support the forage development federations or dairy cooperatives and facilitate development of irrigation system for growing silage crops. To avoid possible monopoly, there would be a need of promoting silage making organizations in each province.

g) **Replacement of local cattle with improved breeds:** Replacement of local cattle should be the priority of breeding program of DLS. This is possible only when the milk marketing outreach is extended. This can be achieved by working with the dairy industries for marketing of raw milk and more importantly the milk products manufactured at local level in an organized way. The later approach can help expand new areas for dairy production.

h) **Develop "fodder tree blocks" in the barren or uncultivated lands:** Fodder trees play crucial role in green matter supply during the winter and the dry summer months. Small landholdings do not encourage farmers to plant fodder trees on their farmlands. However, the increasing area under private barren/ uncultivated lands is an opportunity for forage production intervention. These lands could be utilized under lease with the individual land owners or the municipality for this purpose. Fodder trees could be planted in large blocks (more than 10 ropani) with priority to individual ownership. For this the government should support the farmers in fencing the area and supply of seedlings of farmer choice. This could be an important intervention in the goat pockets and an incentive to the farmers to utilize the uncultivated lands for productive purpose.

Chapter II

Impact of Forage Mission

1. Introduction

68. Forage Mission was implemented with an objective of increasing livestock productivity and production through production of sufficient green matter in the country. It had five outputs: (a) bring additional 45,000ha land under forage production; (b) bring additional 150ha of land under oat and 30ha under berseem cultivation; and (c) reduce feed deficit from 8.3 million MT to 7.1 million MT. The implementing agency was the National Animal Feed and Livestock Quality Management Laboratory (NAFLQML) of DLS. The Mission had planned to cover 15 districts in Phase I, 10 districts in Phase II and 20 in Phase III (Table 25). The Mission was effective only for 4 years (NAFLQML, 2019).

Table 25: Districts covered under Forage Mission

Phase	High Hills	Mid Hills	Terai	Total
I	None	Ilam, Kaski, Kavre, Makawanpur	Banke, Bara, Bardiya, Chitwan, Jhapa, Kailali, Kanchanpur, Morang, Nawalparasi, Rupandehi, Sunsari	15
II	None	Laliptur, Palpa, Sindhuli, Surkhet, Tanahu	Dang, Dhanusha, Mahottari, Sarlahi, Siraha	10
III	Dolakha, Sankhuwasabha	Arghakhanchi, Baglung, Bhaktapur, Dhading, Dhankuta, Gorkha, Gulmi, Kathmandu, Lamjung, Nuwakot, Parbat, Ramechhap, Syangja, Udaypur	Kapilbastu, Parsa, Rautahat, Saptari	20
Total	**2**	**23**	**20**	**45**

69. Of 45 districts, there were two districts in the high hills, 23 in the mid hills and 20 in the terai. There were seven, eight, eleven, seven, nine, one and two districts respectively covered in Province 1, 2, 3, 4, 5, 6 and 7 (Table 26).

Table 26: Districts Covered by Province

Province	Districts covered	Number of districts
1	Ilam, Jhapa, Sankhuwasabha, Dhankuta, Udyapur,Morang, Sunsari	7
2	Bara, Dhanusah, Mahottari, Sarlahi, Siraha, Parsa, Saptari, Rautahat	8
3	Dolakha, Kavre, Makawanpur, Sindhuli, Bhaktapur, Dhading, Kathmandu, Lalitpr, Nuwakot, Ramechhap, Chitwan,	11
4	Kaski, Tanahu, Baglung, Gorkha, Lamjung, Parbat, Syangja	7
5	Palpa, Arghakhanchi, Gulmi, Nawalparasi, Rupandehi, Kapilbastu, Dang, Banke, Bardiya	9
6	Surkhet	1
7	Kailali, Kanchanpur,	2
	Total	**45**

70. Mission major activities could be broadly classified into five categories: (a) promoting forage seed production and supply; (b) increasing forage production; (c) forage conservation; (d) supply of machineries and equipment in support of forage production, conservation and processing; and (e) capacity development. In total Rs 321.207 million was invested while

implementing this Mission. The impacts of these activities were evaluated by administering specific questionnaires at household level (Annex 5).

71. While forage production activities and training were implemented across the Mission districts, the supply of machineries/equipment, silage demonstration and forage seed production on contract were concentrated in some districts and sparse in others. Therefore, the study covered all activities in the selected survey districts, although some districts were focused exclusively for the assessment of machineries and equipment supply and silage making.

2. Study Districts and Sample Size

72. Both hill and terai districts represented the study districts by considering the following factors: (a) districts where the maximum number of Mission packages have reached; and (b) districts to represent the agro-ecozone (hills and terai).

2.1 Impact of Forage Package Program

73. A total of 26 districts (13 Hill and 13 Terai) were selected for household survey. In each district, two Livestock Service Sections of the municipalities, one located in rural and another in urban municipality where forage Mission program had reached, were identified with the help of Veterinary Hospital and Livestock Specialist Service Centres or the district level farmer organizations. One goat group and one goat private firm who participated in the forage Mission from rural municipality, and two cattle or buffalo group or cooperative and three private dairy firms from urban municipality were identified in each of these districts with the help of the staff of the concerned municipal Livestock Service Section (LSS).

74. Following discussion with the executive members of each group/cooperative, three (3) farmers from different hamlets who received forage development support were selected randomly. In total 396 HHs were planned for this purpose. However, the actual HH visits were only 225 due to the absence of some HHs during the survey period. Sampling frame for assessment of impact of forage program is given in Table 27.

Table 27: Sample Size to Assess Impact of Forage Seeds/Seedlings Distribution Program

Details	Municipal LSC 1			Municipal LSC 2			Total per district		
	Dairy	Goat	Total	Dairy	Goat	Total	Dairy	Goat	Total
Number of groups	2	1	3	2	1	3	4	2	6
Number farmers per group	3	3	6	3	3	6	6	6	12
Private firm/farm	3	1	4	3	1	4	6	2	8
Total farmers (samples) per district	9	4	22	9	4	22	18	8	44
Total HH samples of 9 sample districts	81	36	198	81	36	198	162	72	396

75. The impact of training was assessed in terms of farmer self-assessment of percent skills utilized after the training.

2.2 Impact of Machineries and Equipment

76. A total of 26 districts (13 Hill and 13 Terai) districts were visited to assess the impact of equipment and machineries distributed by the forage Mission (Table 28). In total 117 HHs and DLS farms were interviewed who received different sets of machines or equipment from the Forage Mission.

Table 28: Household Survey to Assess the Impact of Equipment and Machineries

SN	District	Hydroponics machine	Chaff cutter including multifunction	TMR	Grinder and mixture	Seed fund	Thresher	Harvester	UMB Machine	Seed Bin	Motor pump	Nursery	Silage making support	**Total**
A	**Terai Districts**													
1	Bara						2				1			**3**
2	Bardiya		2		1	1	1	1		2			5	**13**
3	Chitwan	2	3	1	1		4	1			2		2	**16**
4	Dhanusha	1											1	**2**
5	Jhapa	1	3	1									1	**6**
6	Kailali		1		1				1				1	**4**
7	Kapilbastu	2				1								**3**
8	Mahottari		1				2			1	1			**5**
9	Morang		1										2	**3**
10	Nawalparasi	2		1			1	1				1	1	**7**
11	Rupandehi	1			1								1	**3**
12	Sarlahi	1	1			1	1							**4**
13	Sunsari							3						**3**
	Sub-total	**10**	**12**	**3**	**4**	**3**	**11**	**6**	**1**	**3**	**4**	**1**	**14**	**72**
B	**Hill districts**													
1	Bhaktapur		1											**1**
2	Dolakha	1												**1**
3	Gorkha	1												**1**
4	Kaski	1												**1**
5	Kathmandu	1		1										**2**
6	Kavre		2	2				2	1		1			**8**
7	Lalitpur	1												**1**
8	Lamjung	1												**1**
9	Makawanpur	1		1	1				1					**4**
10	Nuwakot		3	9			4	6		1				**23**
11	Ramechhap	1												**1**
12	Sindhuli										1			**1**
13	Tanahu		1			1		1	1					**4**
	Sub-total	**8**	**7**	**13**	**1**	**1**	**4**	**9**	**3**	**1**	**2**	**0**	**0**	**49**
	Total	**18**	**19**	**16**	**5**	**4**	**15**	**15**	**4**	**4**	**6**	**1**	**14**	**121**

3. Data Analysis

77. Tablets were used to collect data and information from farmer cooperative or individuals and the data so obtained were analyzed for means and averages. Trends were analyzed by using time series data sets.

4. Limitation

78. NAFLQML prepared Annual Reports by Fiscal Year but with limited information on recipient farmers/organizations by activity. This posed problems to identify the households for field survey. Consequently, the actual survey HHs decreased to 225 against the 396 planned for this survey. There was also no documentation on actual area covered under forage production or pasture development. Therefore, the study had to depend on secondary information as provided by the NAFLQML.

5. Findings

79. Each of the major activities undertaken was analyzed for its rate of adoption and/or their impacts on livestock production system. Based on these analyses each of them were rated Satisfactory, Moderately Satisfactory or Unsatisfactory. Activities that made significant contribution to forage mission objectives were rated Satisfactory. Activities that contributed to mission objective but were not well balanced (eg. Forage resource centres) or not completely fitting with the present environment (solar water pumps) for contribution to future livestock development programs were rated Moderately Satisfactory. Similarly, activities that were at less than 50% operation and had little prospects of replication at commercial scale in future were rated Unsatisfactory.

5.1 Forage Seed Production

80. Forage seed production involved three broad areas. These were: (a) seed production under official contract with farmers through the government pasture and forage seed development farms and the DLSOs; (b) supply of seeds and seedlings; and (c) development of forage resource centres.

5.1.1 Forage seed production under contract farming

81. The Mission introduced contract forage seed production system in 2071/72, covering 300ha under oat seed production, 60ha under berseem, 300ha under Teosinte and 50 ha under perennial species. By 4th year of the Mission, a total of 252 MT of seeds were produced under contract farming comprising of 114 MT oat, 87MT teosinte, 38 MT berseem and 13 MT winter vetch. With this initiative, quantity of forage seed produced reached 1,062 MT in 2074/75 (24% from contract seed production) from a mere 25 MT in 2070/71 (Table 29). This is a significant achievement in forage seed production with annual compound growth rate of 112%.

Table 29: Forage Seed Production Trend during the Forage Mission

Year	2070/71	2071/72	2072/73	2073/74	2074/75	Annual compound growth rate
Seed Production, MT	25	31	52	145	1,062	112%

Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML), Annual Reports.

82. With these efforts, the Mission had been successful to establish commercial forage seed producers, such as Gadhimai Agriculture Production, Processing and Research Centre Pvt. Ltd. in Kalaiya, Bara that has been producing about 2.6 T of oat seed and 5.4 MT of Teosinte seed annually. This also has created awareness among the agro-vets who have started forage seed business along with their regular previous business of cereal seeds, pesticides and veterinary drugs. Despite this, import of seed mainly from India is continued. For example, MoALD recorded an official import of 70MT of forage seeds in 2016/17. However, the destination and buyers were unknown. The unofficial import is not accounted which is still significant.

83. In addition, in view of the estimated national seed demand of 2026/27 as given in Table 25 above (Part I, Feed Balance), forage seed shortage will remain the critical challenge to forage development in the future. Because, based on the seed demand estimate there will be a need of increasing seed production by 3 to 14 folds each year depending upon the fodder production option presented in Table 25. This is a herculean job. Therefore, it is important that DLS defines national forage development strategies as soon as possible and bring them into implementation.

5.1.2 Supply of Seeds and Saplings/Seedlings

84. Analysis of the data given in Table 30 below indicates that during the Mission period, NAFLQML supplied a total of 203,593 kg of forage seeds, of which 82.5% comprised of annual species and 18.5% perennial. Of the total annual, 80% comprised the winter crop seeds and the remaining 20% summer. In addition 621 thousand slips of perennial forage species were distributed. These supplies had positive impact both on seed production and forage production.

85. The supply of seeds and slips were most intensive in 2071/72 (66.6% of total supply of seeds during the Mission period). It was below 10% in the initial year and 24% in the final year. The initial year focused on supply of slips and cuttings of perennial species.

Table 30: NAFLQML Seed Supply to Farmers by Species

Crop	2070/71	2071/72	2072/73	2073/74	2074/75	Total
Winter Annuals						
Oat	11,265	102,091	-	-	2	113,358
Barseem	1,915	14,209	-	-	-	16,124
Winter vetch	-	1,832	-	-	-	1,832
Sub-total A	**13,180**	**118,132**	**-**	**-**	**2**	**131,314**
Summer Annuals						
Teosinte	4,160	7,634	-	-	-	11,794
Bajra	-	5,975	-	-	13,803	19,778
Sudan	-	770	-	-	2,300	3,070
Sub-total B	**4,160**	**14,379**	**-**	**-**	**16,103**	**34,642**
Perennials						
Stylo	1,649	65	-	-	16,100	17,814
Joint vetch	-	2,720	-	-	16,700	19,420
Centro	-	220	-	-	-	220
Desmodium	-	160	-	-	23	183
Sub-total C	1,649	3,165	-	-	32,823	37,637
Perennials with vegetative propagation						
Sumba Setaria	-	139,162	-	-	-	139,162
Signal	-	-	-	-	51,142	51,142
Guatemala	-	-	-	-	64,900	64,900
Mott napier	331,000	5,400	-	-	30,000	365,700
Total D	**331,000**	**144,562**	**-**	**-**	**146,042**	**620,904**
Total of A, B and C	**18,989**	**135,676**	**-**	**-**	**48,928**	**203,593**
Percent distribution of seed by year	**9.3%**	**66.6%**	**0.0%**	**0.0%**	**24.0%**	**100.0%**
Percent distribution of seedlings/slips by year	**53.3%**	**23.3%**	**0.0%**	**0.0%**	**23.5%**	**100.0%**

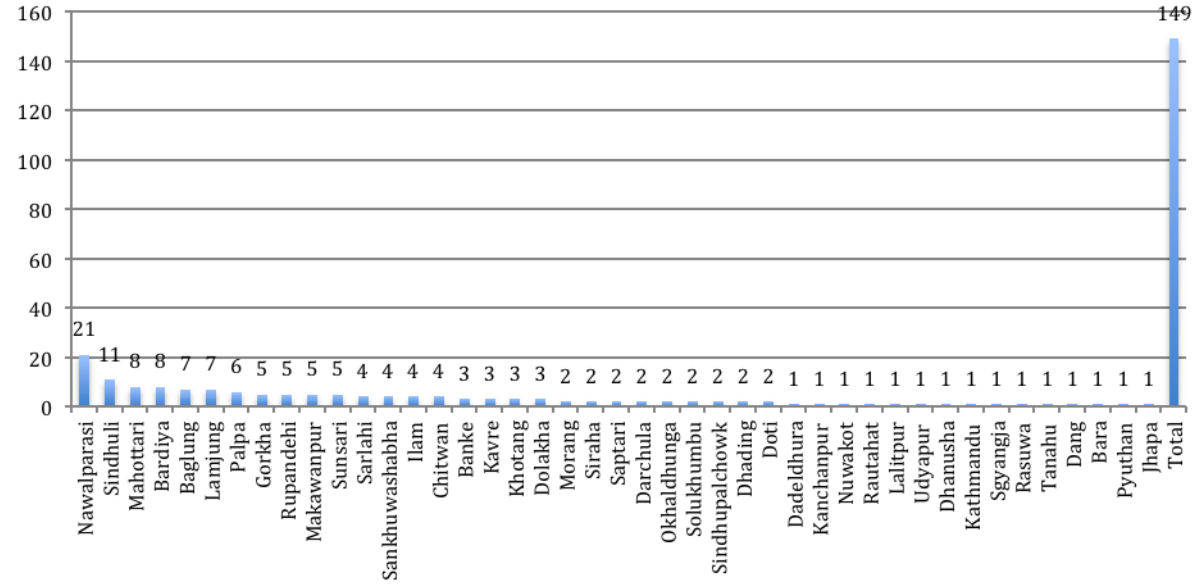
Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML), Annual Reports.

5.1.3 Forage Resource Centers

5.1.3.1 Number of Resource Centers (locations) by Districts

86. The Forage Resource Centers refer to locations where the forage planting materials are produced for sale. They may be owned and managed by a single family, farmer group, or cooperative. These resource centres and the agro-vets were the major suppliers of forage seeds and planting materials for the Mission programme. In total, there were 149 resource centres in 43 districts (Figure 3). The centres were concentrated in only a few districts such as Nawalparasi (21 number), Sindhuli (11), Mahottari (8), Bardiya (8), Baglung (7), Lamjung (7) and Palpa (6). Rest of the districts had less than four centres with majority of districts having less than 2 centres. This indicates that the effort of the Mission to develop resource centres was not well balanced. We should remember that lack of resource centres or sparse resource centres at local level in the past had been the major constraint to forage extension.

Figure 3: Number of Resource Centers by District



Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML), Annual Reports.

5.1.3.2 Diversity of Improved Forage Species in the Resource Centres by District

87. Chitwan (14) seemed to have the largest diversity of improved forage species, followed by Palpa (11), Makawanpur (10), Dhading (9), Nawalparasi (9) and Tanahu (9) (Table 31). While Lamjung and Morang each had 8 species, Dadeldhura, Gorkha, Rupandehi, Sidhupalchowk each had seven species. Thirteen districts had a single species, eight had two species, and two each had three species. Rest had between four and six species. The species ranged from Berseem, Oat, Winter vetch, Teosinte, Sorghum, Stylo, Molasses, Joint vetch, Napier of different types, Amriso, Dinanath, Mulato, Bhatmase, Guatemala, Paspalum, Forage peanut, Desmodium, white clover, ryegrass to a range of fodder tree species. From this, it looks that the resource centres have been working as gene banks for imported species. Gene banks and resource centres are two different things objectively and therefore should be treated differently. It is recommended that DLS prioritizes the forage and pasture crops depending upon the productivity and nutritional values. The resource centres should be developed for only priority crops.

Table 31: Diversity of Forage Species in the Resource Centres by District

SN	Districts	Number of species				
		Winter	Summer	Perennial	Fodder tree	Total
1	Chitwan	1	1	9	3	14
2	Palpa			10	1	11
3	Makawanpur	1		8	1	10
4	Dhading		1	7	1	9
5	Nawalparasi	1	1	6	1	9
6	Tanahu			8	1	9
7	Lamjung	1		7		8
8	Morang	1	2	5		8
9	Dadeldhura	1		6		7
10	Gorkha	1	1	5		7
11	Rupandehi	2	1	4		7
12	Sindhupalchowk			6	1	7
13	Kathmandu	2	1	3		6
14	Sarlahi	2	2	2		6
15	Dolakha	1		3	1	5
16	Doti			4	1	5
17	Sgyangja			5		5
18	Sunsari	1	1	2	1	5
19	Bara	1	2		1	4
20	Sindhuli	1		2	1	4
21	Bardiya	1		1	1	3
22	Khotang	1		1	1	3
23	Banke	2				2
24	Dang	1	1			2
25	Kavre	1	1			2
26	Mahottari	2				2
27	Rasuwa	1		1		2
28	Rautahat	1		1		2
29	Saptari	1	1			2
30	Udyapur	1		1		2
31	Baglung	1				1
32	Darchula			1		1
33	Dhanusha	1				1
34	Ilam	1				1
35	Jhapa	1				1
36	Kanchanpur			1		1
37	Lalitpur	1				1
38	Nuwakot	1				1
39	Okhaldhunga	1				1
40	Pyuthan				1	1
41	Sankhuwashabha	1				1
42	Siraha	1				1
43	Solukhumbu				1	1

Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML). Annual Reports.

5.1.3.3 Resource Centers by Season of Fodder Supply

88. Nationwide, seeds or seedlings for winter forage production would be accessed from 176 centres (Table 32), although capacity of these resource centres is not enough to meet the national demand. It has to be noted that this number does not tally with the numbers indicated above in Figure 3 mainly due to the fact that some resource centres are very rich in species diversity and some other poor. For example, one resource centre in Tanahu works as a source for 9 different species.

89. There were 109 centres (locations) for oat seeds, 20 for berseem seeds and 11 each for Amriso, Ipil ipil and traditional fodder trees for winter feed supply. There were separate resource centres for Bhatmase (7), Tanki (3) and Guatemala (2) and Kimbu (2).

90. Similarly, seeds and seedlings for summer/rainy season feed supply could be accessed from 184 centres. There were 38 centres (locations) for stylo seeds, 32 for napier, 19 for teosinte, 17 for Mulato, 16 for paspalum, 15 for Joint vetch and 14 for setaria. There were however limited centres for seeds of temperate pasture species.

Table 32: Forage Resource Centres by Crops Supplying Fodder by Season

Winter Season Feed Supply		**Summer/Rainy Season Feed Supply**	
Species	**Number of Resource Centres**	**Species**	**Number of Resource centres**
Oat	109	Stylo	38
Berseem	20	Napier	32
Amriso	11	Teosinte	19
Ipil-ipil	11	Mulato	17
Fodder trees	11	Paspalum	16
Bhatmase	7	Jojnt vetch	15
Tanki	3	Setaria	14
Guatemala	2	Molasses	13
Kimbu	2	Forage peanut	9
Sub-total	**176**	Desmodium	5
		While clover	2
		Sorghum	1
		Dinanath	1
		Joint vetch	1
		Rye grass	1
		Sub-total	**184**
		Total	**360**

Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML), Annual Reports.

5.1.3.4 Number of Resource Centers (locations) by Province

91. Province 5 had the largest number of resource centers (45) followed by Province 3 (34), Province 1 (24) and Province 4 (21) (Table 33). Province 7 had only 6 resource centres. To date, all districts in Province 2 have resource centers. Similarly, 85% of districts of Province 3; 71% districts of Province 1; 45% districts of Province 4; 44% districts of Province 7 and 42% districts of Province 5 have resource centres. **Province 6 had no resource centres**. Furthermore, there are yet for DLS to reach remaining 34 districts to develop resource centres. These differences were associated with the initial planning and prioritization of districts for the Mission, therefore the explanation is out of our scope of work.

Table 33: Forage Resource Centers by Province

Details	Province							Total
	1	2	3	4	5	6	7	
Total number of districts	14	8	13	11	12	10	9	77
Number of district having resource centers	10	8	11	5	5	0	4	43
Number of forage resource centres	24	19	34	21	45	0	6	149
Percent districts covered	71%	100%	85%	45%	42%	0%	44%	55%
Number of districts yet to reach	4	0	2	6	7	10	5	34

Source: National Animal Feed and Livestock Quality Management Laboratory (NAFLQML), Annual Reports.

5.1.3.5 Number of Species by Province

92. Table 34 below shows that the resource centers in Province 5 had the highest number of forage species, followed by Province 3, 4, 1, 7 and 2. This indicates that Province 3, 4 and 5 have received greater attention in the establishment of forage resource centres than other Provinces, possibly due to faster growing commercial dairy sector in these areas.

Table 34: Number of Species in the Forage Resource Centers by Province

SN	Forage type	Province						
		1	2	3	4	5	6	7
1	Winter	1	2	2	1	2		1
2	Summer	2	2	1	1	1		0
3	Perennial	5	2	9	8	10		6
4	Fodder trees	1	1	1	1	1		1
	Total	**9**	**7**	**13**	**11**	**14**		**8**

5.1.4 General Observations on Forage Resource Centers

93. There are three major observations on forage resource centres:

a) Resource Centers were not distributed proportionately in all Provinces and districts. They were concentrated in a limited number of districts. Province 6 received little attention in this regard.

b) There were no priority crops defined. All imported species were propagated possibly irrespective of farmer choice. Most resource centres were managed as gene banks.

c) More importantly, the capacity of the Resource Centres was unknown. There is a need of expanding the number of resource centres across the country with their information on seeds/seedlings production capacity (by species) updated on regular basis.

94. Based on the achievement on seed production and status of resource centres as discussed above, the **forage seed production activity is rated Moderately Satisfactory**.

5.2 Fodder and Pasture Development

95. Fodder and pasture development included three major activities: (a) forage development program in general; (b) hydroponic fodder production; and (c) azolla farming. These are discussed below in details.

5.2.1 Forage development program in general

96. Fodder and pasture development included the distribution of planting materials (plant sets and slips, fodder tree seedlings etc.) and seeds to farmers and farmer groups/firms. The

NAFQML reported that the estimated land coverage with forage and pasture was 37,154ha (Namrata Singh, presentation to the DLS Coordination Committee on National Forage Campaign in 2018) (Table 35). However, this achievement is only 82% of the target set for Forage Mission. Moreover, should it set for meeting the future TDN requirement, the annual growth in fodder production area should be increased between 68% and 227% of the total achievement of this Mission, depending upon the type of option adopted as given in Table 25 above. Therefore, it is recommended that **DLS defines crop priorities and appropriate forage development strategies by livestock production pockets and physiography. One such strategy would be to make the forage development groups and federations as well as the forage resource centres responsible under contract for fodder and pasture seed production and area expansion, where DLS implements GIS based field monitoring system.**

Table 35: Area covered under Improved Fodder and Pasture during the Forage Mission

Year	2070/71	2071/72	2072/73	2073/74	2074/75	Total
Area covered, ha	8,892	11,726	5,921	8,535	2,080	37,154

97. By cropped area in the sample cooperatives/firms, the most popular species seemed Teosinte followed by Oat, Sudan grass and Berseem. Other crops of some importance were Napier, Stylo, Sumba Setaria, Mulato and Signal (Table 36). Rest of the crops possibly were unimportant, if these farmers were aware of the value of these species also.

98. At cooperative/firm level, some farmers planted sudan grass in up to 6.47 ropani of land, followed by Bajra in 4.07 ropani and stylo in 1.02 ropani. Oat was planted in 0.62 ropani winter vetch in 0.59 ropani and berseem in 0.29 ropani (per farmer). Area under Napier, Mulato, Sumba Setaria and others occupied less tha 0.1 ropani of land.

Table 36: Changes over Area Under Forage Production Per Farmer (Ropani)

Species	# farmers	Area covered, ha	Area per farmer, ropani
Teosinte	1573	82.47	1.05
Oat (Jai)	2207	68.15	0.62
Sudan	78	25.23	6.47
Berseem	936	13.74	0.29
Napier (Mott. CO4) cuttings	2043	8.60	0.08
Stylo	103	5.24	1.02
Sumba Setaria	4001	1.78	0.01
Mulato seeds	1003	1.53	0.03
Signal	0	1.53	#DIV/0!
Bajra	5	1.02	4.07
(Winter) vetch	12	0.31	0.51
Joint vetch	2	-	-
Dinanath	0	-	#DIV/0!
Paspalum	0	-	#DIV/0!
Centro	0	-	#DIV/0!
Kimbu seedlings	0	-	#DIV/0!
Guatemala slips	1	-	-
Mulato slips	0	-	#DIV/0!
Desmodium	1	-	-

Source: Field Survey 2019.

99. Farmer/oragnizations also reported that the seeds and seedlings were extended to 2 to 12 farmers per cooperative or firm (farmer-to-farmer extension).

5.2.2 Impact of forage production activity

100. The field survey indicated that on-farm forage supply has increased from 34.4% to 53.8% (19.4 percentage points) with simultaneous decrease in straw use by 13.1 percentage

points (n=225) (Table 37) (of farmers who were engaged in improved forage production under the Forage Mission). Before the launching of forage Mission, straw contributed over 46% of total diet of animals, which decreased to one-third after the Mission. This intervention also decreased the dependency of fodder on forest by 6.3 percentage points compared to before Mission. This intervention resulted in increase in milk production by an average of 26%, improved animal body condition by 29% and reduced labor hour by 4.4 hour per day. Milk production per milking animal reached 12.4 liter from 8.84 liter per day in case of cattle and to 8.13 liter from 6.59 liter per day in case of buffalo. Milk sale from a cooperative/firm increased from 14.9 liter per day to 59.4 liter per day after the Mission.

101. In addition, with increased forage supply, farmers have added new animals in their herds. The average dairy cattle added per HH was 2.66, buffalo 0.33 and goats 6.0 heads. Some of these farmers have started using tractors, threshers and harvesters for farm operations. Making or feeding silage is at increase. It addition, decreased use of straw will have a meaningful contribution to negating impact of climate change due to rumen fermentation.

102. Similarly, farmers reported that about 58% of green forage is surplus during Shrawan to Kartik, 21% during Mangsir to Fagun and about 10% during Chair to Baishakh. These surpluses were either made into silage, hay or compost. These are significant achievements of the Mission. **Therefore, this activity is rated Satisfactory.**

Table 37: Changes in Feed Composition Before and After the Forage Mission

Feed sources	Before	After	Difference
Straw	46.1	33.0	-13.1
On-farm forage	34.4	53.8	19.4
Forest fodder/grazing	19.5	13.2	-6.3
Total	**100**	**100**	

Source: Field Survey 2019.

5.2.2 Hydroponic fodder production:

103. Hydroponics is a method of growing green fodder without soil in an environmentally controlled house or shed. The Ministry of Agriculture and Livestock Development (MoALD) introduced hydroponics at farmer level in Nepal in 2072/73 (2015/16) in the eastern region with 75% subsidy on purchase of equipment. The then National Pasture and Fodder Development Centre also distributed 10 machines in the same year and another 10 in the following year (2015/16) at 75 % subsidy. The machines were either automatic or semi-automatic. Most of the automatic machines were small in size with 8 racks (4 on each side) each with holding capacity of 5 trays. Two larger automatic machines were installed one each in Pokhara and Jiri livestock farms with capacity to accommodate 368 trays in 8*2 layers (racks) in 2073/74 (2016/17). The semi-automatic machines were simple tunnel type with GI sheet roofing and equipped with water supply, a cooler and 6 racks to accommodate 108 trays.

104. The then National Pasture and Fodder Development Centre conducted a study in 2074/75 (2017/18) to assess the impact of hydroponic machines and TMR. It reported that 1kg of maize or wheat seed produced 8.7kg of hydroponic green fodder with a cost of production of Rs 5.90 per kg. The benefits were summarized as: (a) high palatability; (b) increased milk and milk fat content; (c) improved breeding performance; and (d) reduced use of concentrate feeds by 51% and corresponding reduction in cost of production by 25%. Major problems in the operation of hydroponic machines were the lack of training, requirement of high voltage electricity, and low seed germination.

105. In the present study we visited 18 of 20 distributed hydroponics machines. Of these only three were at partial operation. Rest (83%) were not in operation. Interactions with the farmers indicated that there was no specific training conducted on operation and maintenance

of machines, neither was there any training on hydroponic fodder production management. The Indian supplier simply installed the machines without imparting any skills in operation and management and fodder production management. Farmers reported that when the suppliers were requested to come to Nepal and help them repair the machines, they asked lump sum Indian Rupees of 35,000 to 40,000 per event.

106. No Nepali electricians had knowledge to set the automatic control panel. It was further reported that to fix any mechanical problem in the automatic machines, there would be a need of three experts - electrical, mechanical and electronic engineers (Shyam Yadav, Livestock Officer, Jiri Livestock Farm, personal communication). This happened mainly due to the fact that there was no warranty of the machinery supplied. Secondly, the machine required high power (3 phase line) and high water supply up to Rs 1.22 per kg of fodder production. Therefore, although the machine was found useful to smallholder farmers, it was not useful to large commercial farmers and farmers in general in water scarce areas. For example, the farmer with the machine (not in operation yet) in Manthali/Ramechhap had adequate water supply (not common to other farmers) and therefore was eager to try out the machine, as the straw was very expensive (Rs 22/kg). However, he felt that the machine was not good enough for larger dairy herds and was supplied without considering the herd size. Most of the machines were for 4 to 6 dairy animal herd.

107. The farmer in Harisiddhi (Lalitpur) received semi-automatic facilities. The machine was operating under capacity. Only 16 out of 108 trays were in use. However, **he was happy that he brought semi-automatic** machine**, which can be fabricated locally at much lower cost than he initially invested**. He said that feeding hydroponics fodder to dairy cows resulted in (a) healthy cattle; (b) normal oestrus; (c) no problem of loose stool; (d) reduced concentrate feeding by about 20-25%; and (e) increased milk production from 7-20%.

108. Further to the analysis, two operations - one at livestock farm, Jiri (government) and one semi-automatic operation - a private farm in Harisiddhi were subjected to cost of production analysis. While the cost of production at government farm was estimated at Rs 8.69/kg green fodder, with 15% depreciation of fixed assets (Annex 3a), the cost of production at private farm was Rs 9.65/kg without and Rs 11.41/kg with 15% depreciation (Annex 3b). Both of these figures are higher than the figure (Rs5.90/kg) reported earlier by the National Pasture and Fodder Development Centre (para 103 above). In addition, other farmers in the rural areas with this machines reported that feeding hydroponic plants was expensive compared to green fodder, which could be produced at Rs 2-5 per kg. These farmers of course had enough land for forage production for their livestock.

109. Major reasons of non-operation of hydroponics machines were: (a) inadequate training to the recipients on operation and maintenance of machine, and hydroponics production and management, (b) high voltage requirement; (c) expensive seeds; (d) lots of hassle in preparation of seeds; (e) expensive hydro fodder compared to green forage; (f) too small for large herds of animals; and (g) silage making or procurement is much cheaper than hydroponics fodder.

110. Based on the above observations and discussions, **this activity is rated unsatisfactory.**

5.2.3 Azolla Farming

111. Azolla is used extensively in China and Vietnam to increase rice yields. It is also being studied in Nepal by NARC and National Rice Programme. Since azolla contains as mush as 25% crude protein, animal scientists worldwide have been studying its value in animal nutrition. Studies have shown that azolla could be fed to all classes of livestock (dairy animals, pigs, poultry etc.) with positive results. It can reduce cost of production by replacement of concentrate feeds and increase animal productivity. It is in this context, the Forage Mission supported ten farmers to cultivate and use azolla in dairy animal feeding.

112. However, the results of the present study were not promising mainly due to inadequate farmer skills in azolla farming, lack of timely and regular supply of azolla culture, and inadequate follow up by experts. Four of five farmers who were visited by the study team had stopped growing azolla. One had continued as he sells azolla seeds at Rs 1,000/kg with added transportation and packing costs. Despite this, he had reduced azolla farming to 16.5 M^2 compared to the start up with a Kattha (338.63 M^2) of land. He is hoping to get support from NARC to construct new ponds and carrying out research. The other farmer who had stopped azolla farming has been trying to work with NARC support with the purpose of selling the culture (seeds).

113. Most of these farmers were small holders keeping only a few animals. Farmers reported that this technology could fit to small holders. As the production is only 500g of fresh azolla per M^2 pond, this technology may not be appropriate for commercial dairy farmers. Moreover, there was no replication noticed out of the support of Forage Mission and was subsidy driven. Therefore, **this activity is rated unsatisfactory.**

114. Similar conclusions were drawn by Indian Scientists in Tamilnadu where a local NGO (REAL) had promoted azolla farming (Tamizhkumar and Rao, 2012). The reasons for dropping azolla farming were: (a) not convinced of azolla feeding to cattle, (b) excess heat, (c) lack of hassle; and (d) lack of space for pond construction.

115. Therefore, it is recommended that before bringing such technologies at farmer fields, it is important that they are tested on station, verified at farmer fields and then taken into extension mainstream. Secondly, to promote the technology we have a tradition of fixing high price of the seeds so produced. This motivates farmers to produce seeds rather than using the outputs for their own purpose. This is the same case like the one in KUBK where the Boer goat breeder farmers stocked out the pure breed off springs rather than rearing them for breed development. Therefore, the prices of such products should be very carefully rationalized.

5.3 Forage Conservation

116. Major forage conservation activity under the Mission was **promoting silage making**. Silage making is one of the major strategies for sustainable dairy farming across the world. Silage making minimizes green forage loss, which is in surplus during the rainy season. It can use crops like napier, teosinte and maize or sorghum crops which produce lot more TDN per unit area than any other crops. Once made correctly, it could be stored for 2-3 years. Most importantly, silage is useful to balance the nutrition of animals at lower cost particularly during the winter and the dry summer when the Nepali livestock suffer the most due to under feeding. It is in this context the Forage Mission implemented silage making promotional activity.

117. During the Mission period farmers were supported to construct a total 431 silo pits of varying sizes at 50% subsidy. Out of these, only 14 farmers were interviewed. On average, 50% of the respondents including two goat farmers from Bardiya had continued making silage by utilizing surplus fodder available in the rainy season at small scale, mostly for their own use. At the same time, one farmer from Rupandehi Mr. Bhesh Raj Poudel has started commercial production of baled silage with capacity of 3MT/hour. At the moment, he has leased 30ha of land for maize production. He buys maize at dough stage from other farmers also at Rs 2.5/kg and sells silage at Rs 12/kg. Farmers reported that the feeding value of silage is almost equivalent to berseem and results in increased milk production by 15 to 20%.

118. Remaining 50% of the respondents reported that their silo pits were not in operation. The main reasons given were: (a) lack of irrigation for silage crop production; (b) lack of appropriate technology (silage was rotten in the pit due to water seepage); (c) sufficient green fodder available for their small herd of cattle; (d) could not chaff the fodder as the chaff cutter supplied by the Mission did not work; (e) expensive fodder chopping and packing as labour is expensive; (e) reduced cattle herd; and (g) change of business (e.g., dairy farming to dairy processing). However, all respondents appreciated the silage as livestock feed and suggested to

expand silage program more rigorously. This means that the silage program under the Mission was successful to create awareness among the farmers. Therefore, **this activity is rated Satisfactory.**

5.4 Supply of Machineries and Equipment

119. In total the forage Mission supported the supply of 1,478 machineries and equipment including construction of silo pits, irrigation ponds and seed fund (Table 38). Of these, one chaff cutter, hay balers, three hydroponics machines, and one TMR machines were provided to the different government farms under DLS. The status of these machineries is discussed in the following paragraphs.

Table 38: Machineries and Equipment Distributed under Forage Mission

SN	Machinery/equipment	2070/71	2071/72	2072/73	2073/74	2074/75	Total
1	Silo pit construction	236		50	145		431
2	Chaff cutter	155		18	10	39	222
3	Seed bin	35	115		20	9	179
4	Pond construction for irrigation	18		33	87		138
5	Wheel barrow		5		74	36	115
6	Harvester	39	39				78
7	Thresher	8	35	25		3	71
8	UMB machine	21	37	13			71
9	Multifunction chaff cutter		40				40
10	Seed fund establishment	10	14	10	3		37
11	TMR machine	1		20			21
12	4 stoke power harvester		4	15			19
13	Pump set with motor (for irrigation)		15				15
14	Grinder and mixer					9	9
15	Sealing machine	4	4				8
16	Hay baler	2	1			2	5
17	Secateurs		5				5
18	Grinder				3		3
19	Moisture meter					3	3
20	Reaper					3	3
21	UMB hydraulic machine	2	1				3
22	Tractor driven thresher		1				1
23	Tractor operated round straw baler		1				1
	Total	**531**	**317**	**184**	**342**	**104**	**1,478**

Source: National Animal Feed and Livestock Quality Management Laboratory. Annual Reports (2070/71 to 2074/75)

120. **Chaff cutter:** The chaff cutter is used for cutting straw and/or green fodder into small pieces to reduce feed waste and increase feed utilization. It also prevents animals from rejecting any part of their feed. With this process, it also reduces methane production. For this purpose, the Mission distributed chaff cutters to the farmers. The chaff cutters varied from simple mechanical to multifunction type. The later type could be used to chaff fodder for silage production also.

121. Of twenty farmers interviewed, fifteen (80%) reported that the equipment were operating well and expressed high level of satisfaction as the use of machine reduced the labor hour significantly (10 to 15 times). Of non-functioning, two farmers reported that the machines could not chaff the straw. One of them stopped using it as his labor lost three fingers while pulling back the unchaffed rolled straw for re-chaffing. Third farmer reported that the machine was not in use, as the supplier did not supply the motor to run the machine. The other farmer reported that the capacity of the machine was too low therefore he is using a different machine, which he brought from his own investment. Based on the overall performance of the machine distributed **this activity is rated Satisfactory**.

122. **Harvesters:** Among the farmers interviewed in Chitwan, Rupandehi, Makawanpur, Kavre, Tanahu, Kailali and Bardiya districts, 5 of 15 interviewed (33.3%) reported that the machines are in use. Remaining 10 farmers (67.7%) reported that the machines were not useful for three reasons: (a) could not operate the harvester as the motor was missing; (b) high maintenance cost; and (c) could not be repaired locally. In addition, the harvesters supplied to the farmers were too small which were suitable mainly to small farmers and not the commercial farmers. **Therefore, this activity is rated Unsatisfactory.**

123. **Total Mixed Ration (TMR) Machine:** Total Mixed Ration (TMR) combines all forages (green or/and dry), grains, protein feeds, minerals, vitamins and feed additives to a specified nutrient concentration into a single feed mix. The TMR or complete ration mix is then offered free choice. The system is adopted for feeding high producing, indoor-housed dairy cows. However, a supplemental grain feeding to high producers may be necessary in one-group TMR system. The benefits of feeding TMR are: (a) useful for farmers with limited or no land for green or dry roughage production; (b) cheaper and easy to transport; (c) better way of managing crop residues; (d) lesser methane production; (e) feed bank could be established for emergency; (f) lesser space for storage; (g) no problems for farmers to formulate ration; and (h) less feed wastage. In this context, the Mission distributed 21 TMR machines to farmers/entrepreneurs/ farmer groups at 75% subsidy.

124. The study undertaken by the then National Pasture and Fodder Development Centre in 2074/75 (2017/18) to assess the impact of TMR machine distribution indicated that only half of the TMR machine distributed by the Centre were in operation. They were making 2, 5 and 15 kg blocks and the cost ranging from Rs22 to Rs 30 per kg. These machines were operating at 15% of capacity (3MT/day versus 19MT/day. Although farmers reported a 10% reduction in cost of milk production, most of the TMR investments suffered from lack of adequate power supply, lack of investment (operating cost), and more importantly introduction of commercial silage by a separate company in their working areas. Silage was sold at much cheaper rate than TMR blocks (Rs 12 vs. Rs Rs22 to Rs 30 per kg).

125. This study covered farmers supplied with small TMR machines. Of 21 TMR machines distributed, 17 recipients were visited/contacted. It was found that none of the machines of these recipients were at full operation. Some farmers were using only the chaffer of TMR machine to chop maize stalk, which is seasonal. Some others used the mixture of the machine to mix the feed ingredients though the process reported was very slow. The machine also could not chaff the straw and the sieve required frequent repairing. Some farmers who used the machine before were mixing the type of amount of feed they practiced on the past. This is against the principle of TMR. TMR should be prepared on the principle of complete balanced feeding.

126. Overall the performance of TMR machine distribution activity is rated Poor. The reasons behind the failure of this activity, as farmers reported, are: (a) lack of hands on training of farmers on operation and maintenance of TMR machine, (b) lack of farmer training on preparation of TMR based on locally available feeding materials; (c) lack of needful technical backstopping; and (d) lack of performance monitoring. Based on the above observations**, this activity is rated Unsatisfactory.**

127. **Feed grinder and mixture machine:** Farmers of Chitwan, Rupandehi, Makawanpur, Bardiya and Kailali were interviewed to assess the value of distribution of feed grinder and mixture machines distributed under forage Mission. One of five respondents reported that the machine is in use for their own animals. Rest four respondents (80%) reported that the grinders were miniature type possibly for spice grinding, therefore were not in use. One of them however, was using the mixture (not the grinder) for mixing home products and feed the livestock. **Based on these observations, this activity is rated Unsatisfactory.**

128. We feel that supply of grinder and mixture machines to small farmers or farmer groups should not be the choice as, (a) a large number of feed mills are in operation in the country; and (b) management of raw materials assembling/procurement and storage requires large investment with complex ingredient and financial management.

129. **Threshers**: When interviewed with 15 farmers of Bara, Bardiya, Chitwan, Mahottari, Nawalparasi, Nuwakot and Sindhuli, only three (20%) farmers reported that the machine was in operation. Remaining respondents (80%) reported that the machine was not in operation. Based on these observations **this activity is rated Unsatisfactory.**

130. **Water pump:** Only eight farmers were interviewed for this activity. Five of them were found working, and the farmers expressed high level of satisfaction. Farmers who had solar pumps, however, reported that the pump does work in the winter but interruptedly. Remaining two farmers reported that their pumps were not working for unknown reasons and the other one farmer closed down the farm. Based on these observations, **this activity is therefore rated Moderately Satisfactory.**

131. **Seed Fund:** Four farmer organizations of Kapilbastu, Sarlahi, Tanahu and Bardiya were interviewed to understand the status of seed fund provided by the Mission. It was observed that the funds were used to lend the farmers for seed production. Some of them received commitments from the farmers that they will return the money if the government wanted them back. However, most of the funds were already depleted and there was no replenishment. Therefore, **this activity is rated Unsatisfactory**.

132. **Other equipment**: Seed bins were in use whether the forage seeds or cereal seeds are stored. Of the six farmers interviewed, none of them were operating UMMB machine. Reasons for non use of the machine were: (a) making UMMB was quite expensive in the hills due to the necessity of using the Gur (jaggery), as molasses was not available; (b) lack of knowledge in UMB preparation; and (c) inappropriate technology – the product was too soft to feed the animals. Therefore, **the distribution of UMMB machine is rated Unsatisfactory.**

5.5 Capacity Development

133. A total of 863 farmers (18% women) received different training under the Mission. Major areas of training were quality seed production, urea molasses feeding, hay and silage making, pasture development and livestock feeding management (Annex 4). Other training included mechanization in livestock feeding management, operation of seed equipment and seed truthfull labeling, total mixed ration (TMR) and hydroponics, climate change and adaptation, social inclusiveness, gender and leadership development and VAHW. In-country exposure visits were also organized for 143 farmers (15% women). In addition, 51 staff (4% women) working in community forage development centres were trained in pasture and feeding management. International technology exposure visits and in-country exposure visits were also organized for 29 DLS staff and focal persons (10% women).

134. Field surveys were conducted to assess the impact of training in terms of percentage skills applied after the training. A total of 225 respondents provide their inputs in this exercise. Over all, the application of training skills was 43.7% indicating that most of the training were not effective enough to meet their objectives (Table 39). The most effective training was related to pasture and feeding management (72% of skills applied) followed by quality seed production

(61%) and mechanization (57%) in livestock feeding management. Rest of the training activities scored below the mark meaning that these training were not as effective as expected to impart practical knowledge and skills to the farmers. The impact of training in hydroponics, TMR and UMB machines was obviously ineffective as discussed above in the respective sections. Surprisingly, the in-country observation tour was also not very effective as only 41% of knowledge and skills applied. This indicates that the tours were not objectively defined based on farmer needs. Based on the scores given by the training recipients for each of the training activities, the **capacity development activity is rated Unsatisfactory**.

Table 39: Percentage skills applied by farmers by type of training

S.N	Name of training	Percent of skills applied
1	Pasture and feeding management	71.7
2	Quality seed production	60.7
3	Mechanization in livestock feeding management	57.2
4	Social inclusiveness, gender and leadership development in leasehold forestry	50.0
5	Hay and silage making	45.8
6	Forage Production Training	45.4
7	Impact of climate change on leasehold forestry and livestock farming, and adaptation	45.0
8	In-country exposure visit to farmers	40.8
9	3 day farmer training on operation of seed equipment and seed truthful labeling	40.6
10	Urea Molasses feeding	40.0
11	3 day TMR and Hydroponics training for entrepreneurs and technicians	35.8
12	Impact of climate change on livestock enterprises and forage development, and adaptation	30.0
13	Impact of climate change on the high altitude livestock farming and pasture development, and adaptation	5.0
	Overall	**43.7**

6. Conclusion and Recommendations:

135. The forage Mission had been successful to achieve a significant annual compound growth rate of 112% in forage seed production through strengthening forage resource centres and encouragement of the private seed growers on contract seed production. There were however limited centres for seeds of temperate pasture species. In addition, the resource centers were concentrated in a limited number of districts with no attention to Province 6 in this regard.

136. Nonetheless, the Mission had been successful to increase land coverage under forage and pasture and attaining the total coverage of 37,154ha at national level. This expansion has increased the TDN share of improved fodder and pasture to 7% in the national TDN supply from among the different feed sources, which used to be insignificant before the Mission. On-farm forage supply has increased from 34.4% to 53.8% (19.4 percentage points) with simultaneous decrease in straw use by 13.1 percentage points (n=225) (Table 38) of farmers who were engaged in improved forage production under the Forage Mission. This resulted in increase in milk production by an average of 26%, improved animal body condition by 29% and reduced labor hour by 4.4 hour per day.

137. Silage making intervention has been rated satisfactory. Among the activities under supply of machineries and equipment, support for chaff cutter, water pumps for irrigation and

harvesters were rate **satisfactory to moderately satisfactory**. Rest of the machines like TMR machine, feed grinder and mixture machine, thresher, UMMB machine, hydroponics machine, TMR machine and the seed funds were rated **Unsatisfactory**.

138. Finally, the application of training skills was 43.7% indicating that most of the training were not effective enough to meet their objectives. Surprisingly, farmers rated the in-country observation tours also not very effective. Therefore, training is also **rated Unsatisfactory**.

139. Nonetheless, **overall rating of forage Mission is Moderately Satisfactory**.

Recommendations

140. In view of the observations and discussions, the following recommendations are made:

1. **Strengthen Existing Forage Resource Centres:** The existing resource centres should be developed as knowledge-cum-resource centres for priority fodder crops. Their capacities to produce and supply seeds and seedlings should be expanded and strengthened through facilitating contract farming, equipping them with all necessary seed sowing, weeding, harvesting, processing and storage facilities, and delivery of forage extension program under objective contract. Concurrently, these centres should be utilized to develop their sister centres for knowledge and feed resources. This strategy is expected to produce more outputs than the traditional method of forage extension. There will also be a need of helping farmers to bring the private seed traders closer for promotion of seed marketing.

2. **Matching grants should be project based/demand led**: Shortage of labor is critical in all rural areas. Therefore, mechanization of forage and forage seed production system should get high priority. This can be achieved by providing matching grants for purchase of machines and equipment by following project based approach, where the farmers/firms are required to submit business plans. It would also be important that the grantees get **adequate skill training in installation, operation and management, and business development**.

3. **Promote optimum input based fodder and pasture development program**: We should learn from the past that forage or pasture block development efforts without irrigation and fertilization in the past had been futile. Therefore, low input low output concept of forage or pasture development should be changed to yield optimization principle with optimum inputs management.

4. **Pasture development activity in the high hills should be coupled with an investment project:** The high hills in Nepal keep the highest potential for livestock production in the country due to its endowment with large tacks of rangelands. However, the pasture development activities in these areas will remain ineffective until there is investment opportunity in the livestock sector. Therefore, the government should take initiative to seek resources for livestock sector investment so that the rangelands could be effectively developed for building sustainable national asset.

5. **Develop "fodder tree blocks" in the barren or uncultivated lands:** Fodder trees could be planted in large blocks (more than 10 ropani) in private of barren or uncultivated lands with priority to individual ownership. For this the government should support the farmers in fencing the area. This could be an important intervention in the goat pockets and an incentive to the farmers to utilize the uncultivated lands for productive purpose.

6. **Promote commercial silage manufacturers:** Silage making is one of the climate smart livestock production technologies for livestock productivity enhancement. There are a few entrepreneurs coming up with commercial silage production. However, there is a need to establishing such enterprise in all provinces. Therefore, DLS should promote such enterprises by providing matching grants based on business plan to

interested parties. While the enterprises will be responsible for contract farming management, silage production and marketing, DLS/municipal livestock sections may have a role of (a) providing support to farmers in developing irrigation system, (b) quality control, and (c) encouraging farmers to use silage.

7. **Stop implementing subsidized activities where private sector investment would be more appropriate:** Distribution of equipment such as grinder and mixture, UMMB machine and TMR machine should not be DLS intervention. These are the areas where the private sector can contribute. DLS could promote the private sector facilitating the lending process, sharing technologies and quality control.

8. **Emphasize on objective exposure visits:** The exposure visits should be objectively defined before they are implemented. This will require assessment of farmer needs and organizing visits to meet their needs.

9. **Need for focused forage research:** There is s need of focused research on improving forage and seed productivity and reducing cost of forage/seed production. For this, DLS should be working together with NARC and Fodder/Seed Producer groups for identifying appropriate research areas and managing research activities. Secondly, the NARC research system should be improved by working beyond the research outputs. Rate of adoption of research outputs should be part and parcel of the research activities. Thirdly, there is a need of developing appropriate method/s of making silage from crops other than maize with grain cobs. First priority crop would be silage making from napier an local grasses. Such trials should be multi-locational and multi-agency e.g., NARC, University and DLS. Fourthly, the DLS in consultation with NARC and experts should import winter growing crops, test them and put them in the extension system after field verifications. Finally, DLS and NARC should also study the productivity of local species in terms of biomass production and nutritive values. The promising ones would be those that are evergreen and supply fodder during the winter and/or summer. Study of selected indigenous species in the recent study could be a good start.

10. **Need for introduction/replacement of forage seeds**: It is important to note that many forage seeds imported long time back in Nepal require replacement. Attention is also required to import, test and multiply species such as tropical rye grass and lucerne. To make this program successful, there is a need of establishing a network for production and distribution of foundation and certified seeds.

11. **Establishment of gene banks**: The on-going study on "Indigenous Species of Forage and Strategy for their Conservation and Promotion" indicates that there are unexplored forests species which make up the major feed of livestock in general and of goat in particular. There may be many more species when exploration undertaken countrywide. There is a need of giving adequate attention to identify, test and multiply at farmer level. The seeds of such species should also be stored in the forage gene banks. The government should encourage farmer groups also to establish such gene banks.

12. **Establishment of database**: Inadequate or lack of documentation is the major problem in feed development program. The area covered under improved forage or pasture is simply estimated by distribution of seeds and seedlings. Following would be major flaws of such crude estimation system: (a) in many cases farmers use higher seeding rates than recommended. While planting napier or broom grass, farmers usually over populate the planted area. In such cases, the area is over-estimated; (b) estimating area under improved forage in the community or leasehold forests is even more complicated as, in many instances, the planted forages are eliminated due to excessive tree canopy closure; (c) estimated area under fodder tree seedlings plantations is even complicated as planted seedlings mortality may range from 30 to 80% depending on species. Therefore, there is a need of establishing strong database at

central and municipal level on inputs and outputs, which provide clear view as far as the investment/inputs and outputs are concerned.

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Annex 1: Leasehold Forestry Program Districts

Province/district	LHF programs
Province 1	Bhojpur, Okhaldhunga, Panchthar, Khotang, Tehrathum
Province 2	None
Province 3	Chitwan, Dhading, Dolakha, Makawanpur, Ramechhap, Sindhuli, Sindhupalchowk, Kavre
Province 4	Lamjung, Tanau, Gorkha, Syangja
Province 5	Arghakhanchi, Gulmi, Palpa, Nawalparasi, Pyuthan
Province 6	Salyan
Province 7	Baitadi, Dadeldhura, Doti and Achham

Annex 2 (a): Checklist for Focus Group Discussions on Utilization of Forests not Grazed

1) District……..
2) Location/village…….. Municipality……..
3) Type of forest (Community/Leasehold):……..
4) Name of forest……..
5) Area……..
6) Name of user group ……..
7) Number of members in the user group……..
8) Names of contact person (1) …….. Mobile number…….. (2) …….. (Mobile)……
9) Main months of fodder collection:……..
10) Number of HHs collecting fodder by month:……..
11) Total quantity of fodder collected per HH: ……(kg fresh)
12) Do you think all fodder available in the forest is completely collected (utilized)? Yes/No
    If not, what percent of total available fodder is collected?.....What percent remains in the forest?.....
    Why?.....
13) What percent of forest is accessible for fodder collection? ……..
14) Contribution of each source in livestock feed supply?
    a. Fodder collection from forest
    b. Fodder collection from farm lands (weeds and grasses)
    c. Agricultural by-products (straw, bhusa etc. but not grain by-products like bran, cakes etc)
    d. Grazing

Annex 2 (b): Checklist for Focus Group Discussions on Utilization of Forests that are Grazed (To assess the level of utilization)

1) District……..
2) Location/village…….. Municipality……..
3) Type of forest (Community/Leasehold/government):……..Area…….
4) Name of forest……...
5) Name of user group ……..
6) Number of members in the user group……...
7) Names of contact person (1) ……... Mobile number……... (2) …….. (Mobile)……
8) Main months of livestock grazing……
9) Distance to the forest (walking distance)……...
10) Number of HHs taking animals to forest for grazing……
11) Types of animals taken to forest for grazing (goat/sheep/cattle/buffalo)……...
12) Number of HHs bringing back load of fodder while bringing back the animals from forest grazing…….
13) Main months when fodder is harvested and brought home……...
14) Average weight of a back load……..kg
15) Forage abundance in the forest

Status	Mangsir to Fagun	Chait to Asar	Shrawan to Kartik
…… percent more than required (+)			
Just enough (equal to requirement)			
… percent less than required (-)			

16) What percent of fodder available in the forest is actually being utilized (accessibility)? ……..
17) What is the condition of forest? (growing, constant, degrading):……..
18) Contribution of each source in livestock feed supply?
    a. Fodder collection from forest
    b. Fodder collection from farm lands (weeds and grasses)
    c. Agricultural by-products (straw, bhusa etc. but not grain by-products like bran, cakes etc)
    d. Grazing

Annex 3a: Cost of Hydroponic Forage Production at Jiri Livestock Farm

SN	Details	Unit	Quantity/ year	Price/unit	Total cost
A	**Fixed cost**				
1	Cost of machine	Number	1	2,800,000	2,800,000
2	Shed construction for the machine	Number	1	70,000	70,000
3	Water tanks (Hill Take, 1000 liter capacity)	Number	2	12,000	24,000
4	Water pipe		Lump sum		10,000
5	Seed cleaning aluminum tub	Number	2	5,000	10,000
	Total				**2,914,000**
B	**Recurrent cost**				
1	Maize seeds for 6 months with 3 day rest period per month at 1kg per tray at 9 days interval (46 trays harvested per day)	kg	6900	41	282,900.00
2	Wheat seed for 6 months with 3 days rest period at 1kg per tray at 9 days interval (46 trays harvested per day)	kg	5520	31	171,120.00
3	Labor (0.5 labor day/day)		162	700	113,400.00
4	Electricity cost (2.5 unit per day at Rs 9/unit)	Unit	810	9	7,290.00
5	Water requirement	Liter	729000	0.25	182,250.00
6	Bleaching powder (100g/100 liter of water)	kg	729	50	36,450
7	Maintenance cost, per event		Lump sum		65,000
8	Depreciation (15%)				437,100
	Total				**1,295,510**
C	**Benefit**				
1	Fodder production at 10kg forage per tray	kg	149040		149,040
2	Cost of production per kg of hydroponics fodder				8.69

Annex 3b: Cost of Production at Harisiddhi, Lalitpur

A	**Fixed cost**	
1	Cost of machine	480,000
2	Shed construction	80,000
3	Water tank 500l	1,500
	Sub-total	**561,500**
B	**Recurrent cost**	
1	Number of trays used	108
2	Fodder harvest interval during summer, days	11
3	Number of replacement	16
4	Maize seeds @1.25kg for 6 months, kg	2,209
5	Seed cost @ Rs 35/kg	77,318
6	Wheat seed in the winter for 6 months	2,209
7	Seed cost @ Rs 40/kg	88,364
8	Total seed cost	165,682
9	Adjusted seed cost at 5% waste	173,966
10	Water use at 170 liter per day @ Rs0.25/liter	7,013
11	Electricity @Rs 450 per month (average)	5,400
12	Labor cost, 30 minutes per day @Rs 800/day	18,250
	Total recurrent cost per year	**204,628**
C	Depreciation	37,433
D	**Total cost per year**	**242,062**
E	**Fodder production**	
1	Winter	9,720
2	Summer	11,487
3	**Total fodder production, kg**	**21,207**
F	**Cost of fodder production, Rs/kg**	**9.65**
G	**Cost of fodder production including depreciation, Rs/kg**	**11.41**

Annex 4: Type of Training and the Number of Participants

SN	Activity	Total		
		Men	Women	Total
1	In-country exposure visit to farmers	122	21	143
2	Quality seed production	141	35	176
3	Urea Molasses feeding	116	24	140
4	Hay and silage making	19	5	24
5	Pasture and feeding management	57	11	68
6	Impact of climate change on leasehold forestry and livestock farming, and adaptation	30	12	42
7	Impact of climate change on livestock enterprises and forage development, and adaptation	36	7	43
8	VAHW training	15	0	0
9	High altitude pasture development	34	0	34
10	7 day high altitude pasture development	18	1	19
11	3 day TMR and Hydroponics training for entrepreneurs and technicians	14	1	15
12	3 day farmer training on operation of seed equipment and sed truthful labeling	14	2	16
13	Impact of climate change on the high altitude livestock farming and pasture development, and adaptation	17	3	20
14	Social inclusiveness, gender and laedership development in leasehold forestry	30	31	61
15	VAHW refreshed training (2 weeks)	31	5	36
16	Mechanization in livestock feeding management	26	0	26
	Total	**720**	**158**	**863**
1	Pasture and feeding management training for staff working in community forage development centres	49	2	51
2	International feed technology exposure visit to DLS technical staff	14	1	15
3	In-country exposure visit to DLSO focal persons	12	2	14
	Total	**75**	**5**	**80**

Source: National Animal Feed and Livestock Quality Management Laboratory. Annual Reports (2070/71 to 2074/75.

Annex 5: Field Survey Questionnaires

Annex 5(a): Forage package program

1. Date:……..
2. District……Municipality…… Village……
3. Name of group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..Men……. Women……
5. Name of contact person…… Contact number……..
6. Details on forage seeds/seedlings (firm/Group/Cooperative)

Type of seeds/seedlings	Number of recipient farmers		Quantity received (kg/number)		Area covered (Ropani/Katha?)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Oat						
Berseem						
(Winter) vetch						
Teosinte						
Sudan						
Bajra						
Stylo						
Joint vetch						
Dinanath						
Paspalum						
Sumba Sateria						
Centro						
Mendula						
Kimbu						
Guatemala						
Mulato						
Napier (Mott. CO4)						
Signal						
Desmodium						
Others, specify…….						
Others, specify…….						

7. What other supports did you receive?
   a…….
   b……
   c……..
8. How many farmers (non-members) outside your group/cooperative have taken up the forage technologies that you have been adopting?.....

Note:

1) **If it is a firm (Individual) go straight to the following questions.**
2) **If it is a group or cooperative, take three farmers (priority women headed HHs from different clusters - Tole), who had participated in forage Mission and administer the following questions.**

9. Name of farmer:…….. Contact Number…….. Name of Tole……..
10. Land holdings and utilization for forage production

Total Land holding (Katha/Ropani)				Area under forage production				Total green forage production, kg
Own land		Leased land		Crops	Name of crops	Khet (Kattha / Ropani	Bari (Kattha/ Ropani	
Khet	Bari	Khet	Bari	Winter forage				
				Summer forage				
				Perennial forage				
				Total				

11. Animal holdings

Species	Number milking	Number non-milking	Total number of animals	Total milk production (liter/day)	Total milk sale, liter/day	Milk price (Rs/liter)
Cattle						
Buffalo						
Goats						

12. Sources of feed

Sources of feed	**Proportion of supply by source (%)**	**Proportion of supply by source (%) (Before Mission support)**
Straw		
On farm green forage supply		

Feed collection from forest		
Animal grazed		
Total	**100**	**100**

13. Status of green forage supply by season

	Shrawan to Kartik	Mangsir to Fagun	Chait to Asar
When do you have surplus forage (√) tick			
What proportion of total production is surplus (%)			
What do you do with the surplus fodder?			

14. What were the major benefits of forage program? (increased milk production by (x) percent, reduced labor hour by (y) hour, increased animal body condition by (z) percent, added new animals, started farm mechanization such as use of harvester/reaper for forage harvesting etc.)
    a)……..
    b)……..
    c)……
    d)……..
15. Do you have plan to extend the forage program, if yes what percent of land would you like to allocated for forage production? …… (% of total land)
16. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

17. Frequency of visits by extension service providers (number of visits per month) after interventions by forage Mission……..
18. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(b): Seed Production on Contract

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Who has contracted with you for seed production:
   Name of organization…… Address……..
   Contract period……
7. Seed production details

Species	Seed production, kg					
	This year		Last Year		Before last year (3 years ago)	
	Production, Kg	Number farmers engaged	Production, Kg	Number farmers engaged	Production, Kg	Number farmers engaged
1.						
2.						
3.						
Total						

8. Seed marketing details

Seed type (species)	Name of buyer	Total seed sold, kg	Price /kg seed	Number of farmers engaged in seed production	
				Under contract farming	Out of contract farming
1.					
2.					
3.					

9. Do you have a seed processing facility?.....
10. What support did you get for establishment of seed processing facilities
    ……..
    ……..
    ……..
11. What is its processing capacity?
12. How did you manage to install the seed processing facilities? (GoN subsidy or what?)
    ……
13. Are the seeds tested for moisture? (Yes/No)

If yes,

a) From where you got the moisture meter?.....

b) What is the moisture maintained in seeds?.....

14. Are the seeds labeled? (Yes/No)
    If yes, how do you label …… **(Take photo of seed label)**
15. What are the sizes of seed packages?.....
16. How did you decide the price of seeds?

……..
……

17. Have also received the seed fund (year)……How much (amount) Rs……
18. Is the seed fund operational at the moment (Yes/No)
    If yes,
    a) How much is the seed fund at the moment? Rs ……..
    b) How much is the member contribution? Rs……. per kg seed sold and …….. Rs/month……..
19. Have you got seed fund management guidelines (Yes/No)
    Have you read it? Yes/No
20. Does the guideline provide adequate information to manage the seed fund? Yes/No
    If no, what are the gaps?

……..
……
……

21. For what purposes the seed fund is utilized?

    ……..
    ……
    ……

22. If it is used for lending, what is the interest rate?.....

23. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

24. Frequency of visits by extension service providers (number of visits per month)……..
25. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5 (c): Silage Demonstration/Silage Pit Construction

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Number of farmers who took part in silage making demonstrations by
   Year 1……. Year 2……. Year 3…….
7. How many of them have started making silage?.....
   Individual information
8. Kinds of supports received (For silage making): ……, ……, ……..
   ……, ……
9. Size of silo pit…….. (length X breadth X depth or height) ft
10. Types of crops used for silage making:……., ……., ……
11. Number HHs making silage making after you started (within community……..and outside the community …… number
12. Types of animals fed with silage……..Months when silage is fed……
13. Quantity of silage fed per animal per day (kg) ……..
14. Proportion of straw in the animal's silage diet …….. (%)
15. Impact of silage feeding

Increase in milk production by (%)	Decrease in concentrate feeding (%)	Increase in milk sale (%)	Increase in income per HH (%)

16. Sale of silage, if any (quantity per year and price by year
    Year 1……kg at ……..Rs/kg….. Year 2……kg at ……..Rs/kg ……..
    Year 3……kg at ……..Rs/kg ……
17. Major problems encountered

18. Forage production

	Species	Area cultivated (katha/Ropani)	Fodder harvested (kg)
Annual winter fodder	1. 2.	1. 2.	1. 2.
Annual summer fodder	1. 2.	1. 2.	1. 2.
Perennial fodder	1. 2.	1. 2.	1. 2.

19. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

20. Frequency of visits by extension service providers (number of visits per month)

21. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(d): Hydroponics

1. Date:……..
2. District……Municipality…… Village……
3. Name of group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. **In case of individual** HH or firm, provide the following details

Land holding area		Cattle, Breed ……			Buffalo, Breed …….			Goat
Khet (Kattha/ Ropani	Bari (Kattha / Ropani	Milking	Non-milking	Total milk production, liter/day	Milking	Non-milking	Total milk production, liter/day	

7. When did you receive this machine (year)……
8. How much did you pay for this machine?.....
9. What was the actual price of the machine?.....
10. Type of machine (automated/semi-automated):……..
11. Machine capacity……..
12. Number of trays in the machine?.....
13. Tray Capacity (kg seed per tray)……..
14. Who owns the machine? (Individual/group/cooperative/firm), (√ as appropriate).
15. Have you got an operational manual for this machine (operation, repair and maintenance)? ……..(Yes/No)
16. If yes, how useful is this? (very useful/useful/not useful), (√ as appropriate). Any remarks……
17. Have you got a manual describing the procedures to produce hydroponics plants from different crop species? ……..(Yes/No)
18. If yes, how useful is this? (very useful/useful/not useful), (√ as appropriate). Any remarks……
19. Is the machine operational (Yes/No)…….
20. If Yes, move ahead from question **21.**
21. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
22. What are the months when the machine is in use?.....
23. Number of trays sown in a day……..
24. Type of seeds (crops) grown (maize, wheat etc)……..
25. Quantity of seed used per tray, kg……..
26. Price of seed (Rs/kg)……..
27. Number of trays harvested per day……
28. Green forage production per tray (kg)……..
29. How long it takes to grow seeds for harvesting, days ……..
30. Seed cleaning time (removing broken seeds) per day (hr)……..
31. Seed washing time per day (hr)……
32. Other time required in hydroponics forage production (hr/day)……..

33. Cost of chemicals for seed cleaning and soaking? (Rs/tray)……..
34. Electricity bill (Rs/month) …… (cost of operation)
35. Who provides maintenance services…….. Distance……..
36. Annual maintenance (repair) cost, if any…… (Rs /annum)
37. Type of animal fed with hydroponics grass (milking animals/goats/chicken/all animals), (√ as appropriate)
38. Quantity of hydroponics fed per animal per day…….
39. Feeding concentrate feeds to dairy animals

	Quantity of concentrate feeds offered to dairy animals (kg/day)	Price of concentrate feed (Rs/kg)
When fed with hydroponics		
When hydroponics is not in use		

40. What other feeds are fed to livestock in addition to hydroponics forage?
    a. ……
    b. ……
    c. ……..
41. What is the straw proportion to total feed when fed with Hydroponics grass (per day per animal)? (…… kg straw and ……kg hydroponics grass per day)
42. What used to be the proportion of straw of total feed when you did not have hydroponics system in place? (…… kg straw and ……kg hydroponics)
43. What is the price of straw (Rs/kg)……..
44. What is the price of green fodder? If purchased (Rs/kg)……..
45. Reasons for choosing hydroponics
    d. ……
    e. ……
    f. ……..
46. Did it meet your expectations?

If yes, how

……

……

If no, why?

……

……

47. Type of training received

S.N	Name of training	Duration	Who offered the training	Percent of skills applied
1				
2				
3				
4				
5				

6				

48. Frequency of visits by extension service providers (number of visits per month)?
    After operation of hydroponics machine…….. Before operation……..
49. Suggestions for improvement in the implementation of such activities in future.
    g. ……
    h. ……
    i. ……..

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(e): Water Pump

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Provide the following details (only for an individual farmer or a firm)

Land holding area		Cattle, Breed ……			Buffalo, Breed …….			Goat
Khet (Kattha / Ropani	Bari (Kattha/ Ropani	No. Milking	No. Non-milking	Total milk production, liter/day	No. Milking	No. Non-milking	Total milk production, liter/day	

7. When did you receive this pump (year)……
8. How much did you pay for this pump?.....
9. What was the actual price of the pump?.....
10. Capacity of pump (HP and liter of water pumped per hour <u>specify</u>), HP……. And water discharge……. Liter per hour.
11. Who owns the pump? (Individual/group/cooperative/firm), (√ as appropriate).
12. Is the Pump operational (Yes/No)…….
    If Yes, move ahead from question **<u>14.</u>**
13. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
14. Area irrigated…….. (bigha or Kattha, <u>specify</u>)
15. Number of member HHs served ……
16. Number of non-member HHs served …….
17. What is the rent per hour or per bigha (specify) for use of the pump?, …… Rs/hour
18. For how many days it is rented in a year? ……. days
19. Total service fee collected per year, Rs ……..
20. What would be cost of <u>per hour</u> use of pump (**fuel etc**.) ? Rs…….
21. What is the annual maintenance cost? Rs……..
22. Forage production (Individual/group/cooperative). If it is a group/cooperative, provide the list of farmers with the following information:

Fodder type	**Species**	**Area cultivated (katha/Ropani/Bigha, <u>Specify</u>)**		**Increase in forage supply by (%)**
		Before supply of pump	**After supply of pump**	
Annual winter fodder	1. 2.	1. 2.	1. 2.	
Annual summer	1. 2.	1. 2.	1. 2.	

fodder				
Perennial fodder	1. 2.	1. 2.	1. 2.	

23. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

24. Frequency of visits by extension service providers (number of visits per month)

25. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(f): Harvester/Reaper

1. Date:…….. Tick (√) Harvester /Reaper
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Provide the following details

Land holding area		Cattle, Breed ……			Buffalo, Breed …….			Goat
Khet (Kattha/ Ropani	Bari (Kattha/ Ropani	No. Milking	No. Non-milking	Total milk production, liter/day	No. Milking	No. Non-milking	Total milk production, liter/day	

7. When did you receive this machine (year)……
8. How much did you pay for this machine?.....
9. What was the actual price of the machine?.....
10. Type of machine (common/multifunction)……..
11. Capacity of the machine (Katha/ropani harvested/hour)……..
12. Is the machine operational (Yes/No)…….
13. If Yes, go to question **15.**
14. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
15. Forage production (Individual HH)

	Species	Area cultivated (katha/Ropani)	Total fodder harvested (kg)
Annual winter fodder	1. 2.	1. 2.	1. 2.
Annual summer fodder	1. 2.	1. 2.	1. 2.
Perennial fodder	1. 2.	1. 2.	1. 2.

16. Major crops harvested?

1	2	3	4	5

17. What other things do you do with this machine?
    ....., ..., ...
18. How much area is harvested in an hour?..... (bigha or ropani or katha, specify)
19. If you had used labor, how many labors would be required to harvest the same area?.....

20. What is the labor cost per day? …….
21. Total days the machine is at work in a year……days
22. Number of member HHs served …….
23. Number of non-member HHs served …….
24. What is the rent per hour or per bigha (specify) of use of machine?, ……. Rs/hour
25. For how many days it is rented in a year? …… days
26. Total service fee collected per year, Rs ……..
27. What would be cost of <u>per hour</u> use of harvester (fuel, driver etc.) ? Rs…….
28. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

29. Frequency of visits by extension service providers (number of visits per month)……..
30. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5 (g): Chaff Cutter

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/firm……..
4. Name of contact person…… Contact number……..
5. Provide the following details

Land holding area		Cattle, Breed ……			Buffalo, Breed …….			Goat
Khet (Kattha/ Ropani	Bari (Kattha / Ropani	No. Milking	No. Non-milking	Total milk production, liter/day	No. Milking	No. Non-milking	Total milk production, liter/day	

6. When did you receive this machine (year)……
7. How much did you pay for this machine?.....
8. What was the actual price of the machine?.....
9. Type of chaff cutter (common/multifunction)……
10. Capacity of chaff cutter machine (Kg fodder chaffed/hour)…….
11. Who owns the machine? (Individual/group/cooperative/firm), (√ as appropriate).
12. Is the machine operational (Yes/No)…….
13. If Yes, move ahead from question **15.**
14. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
15. Forage production (Individual HH)

	Species	Area cultivated (katha/Ropani)	Fodder harvested (kg)
Annual winter fodder	1. 2.	1. 2.	1. 2.
Annual summer fodder	1. 2.	1. 2.	1. 2.
Perennial fodder	1. 2.	1. 2.	1. 2.

16. What fodders are chaffed?

1	2	3	4	5

17. What other things do you do with this chaffer?
    ....., ..., ...
18. Do you also chaff straw? (Yes/No)

If yes, is it in single or in combination with other forage?.....

19. Percent straw mixed with green forage……..

20. What are the benefits of chaffing?

Tick (√) as appropriate				
Increase in straw intake	Increase in milk production	Decrease in feed wastes	Decrease in labor hour	Others, specify……

21. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

22. Frequency of visits by extension service providers (number of visits per month)

23. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(h): Thresher

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Forage seed production

Crops under seed production	Area	Total seed production	Quantity of seed Sold	Where was the seed sold	Price (Rs/kg)	Size of bags

7. When did you receive this machine (year)……
8. How much did you pay for this machine?.....
9. What was the actual price of the machine?.....
10. Who owns the machine?.....
11. Type of machine (common/multifunction)……..
12. Capacity of the machine (Katha/ropani threshed /hour)……..
13. Is the machine operational (Yes/No)…….
14. If Yes, go to question **16.**
15. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
16. What other crops do you thresh with this machine?
    ....., ..., ...
17. What is the total area of crop that you have been threshing with this machine (per year)?..... (bigha or ropani or katha, specify)
18. How much time it takes to thresh the crop harvested from a Bigha?.....
19. If you had used labor, how many labors would be required to thresh the crop harvested from a Bigha?.....(number of labor days)
20. What is the labor cost per day? ……
21. Total days the machine is at work in a year……days
22. Number of member HHs served ……
23. Number of non-member HHs served …….
24. What is the rent per hour or per bigha (specify) of use of machine?, …… Rs/hour
25. For how many days it is rented in a year? ……. days
26. Total service fee collected per year, Rs ……..
27. What would be the cost of per hour use of Thresher (fuel, driver etc.) ? Rs…….

28. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

29. Frequency of visits by extension service providers (number of visits per month)……..
30. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(i): Seed Fund

1. Date:……..
2. District……Municipality…… Village……
3. Name of group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. When did you receive the seed fund (year)……How much (amount) Rs……
7. Is the seed fund operational at the moment (Yes/No)
   If yes, how much is the seed fund at the moment? Rs ……..
   If no, why?....., ……, ……..
8. If yes, how much is the member contribution ? Rs……. per kg seed sold and ……..
   Rs/month (<u>what ever</u>)
9. If yes, have you got seed fund management guidelines (Yes/No)
10. Have you read it? Yes/No
11. Does the guideline provides adequate information to manage the seed fund? Yes/No
    If no, what are the gaps?

……..
……
……

12. For what purposes the seed fund is utilized?

……..
……
……

13. If it is used for lending, what is the interest rate?.....
14. Forage seed production

Crops under seed production	Area	Number of farmers engaged		Total seed production	Quantity of seed Sold	Where was the seed sold	Is it on contract* (Yes/No)	Price (Rs/kg)
		Members	Non-members					

* *if the seed production is on contract, take a photocopy or photo of the contract copy.*

15. What seed processing facilities do you have?

……
……..
……..

16. What is its processing capacity? …….. kg/hour
17. How did you manage to install the seed processing facilities? (GoN subsidy or what?)

18. Are the seeds labeled? (Yes/No)…… **(Take photo of seed label)**
    Moisture meter
19. Do you have a moisture meter?
20. How much did you pay? Rs……
21. What was the actual price? Rs……..
22. Is it operational (Yes/No)
23. What moisture is maintained for seeds? ……..
24. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				

25. Frequency of visits by extension service providers (number of visits per month)……..
26. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(j): Seed Bins, Secateurs, Sealing Machine

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Type of equipment……
7. Price of equipment……..
8. Capacity of equipment……..
9. Subsidy of GoN……..
10. Is the equipment in operation (Yes/No)
11. Did this meet your expectations

    If yes, how?

    If not why?

12. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

13. Frequency of visits by extension service providers (number of visits per month)……..
14. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(k): Grinder and Mixture Machine

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. When did you receive this machine (year)……
7. How much did you pay for this machine? Grinder machine..... Mixture machine……..
8. What was the actual price? Grinder machine?..... Mixture machine……..
9. Capacity of grinder machine (Kg /hour)……..
10. Capacity of mixture machine (Kg /hour)……..
11. Who owns the machine? (Individual/group/cooperative/firm), (√ as appropriate).
12. Is the machine operational (Yes/No)…….
13. If Yes, move ahead from question **15.**
14. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
15. Feeds produced

SN	Types of feed produced	Quantity of feed produced per day, kg	Quantity of feed sold per day, kg	Price of feeds, Rs/kg	Where is the feed sold ? (address)
1					
2					
3					
4					
5					
6					
7					
8					

16. Problems associated with procurement of feed ingredients?
17. Problems associated with feed quality?
18. Problems associated with feed marketing?
19. Annual turn over, Rs
20. Reasons for installing these grinder and mixture machine
21. Did this meet your expectations?
    If yes, how?
    ……..
    ……..

    If not, why?

    ……
    ……..

22. Type of training received

S.N	Name of training	Duration	Who offered the training	Percent of skills applied
1				
2				
3				
4				
5				
6				
7				

23. Frequency of visits by extension service providers (number of visits per month)?
    After operation of machine…….. Before operation……..
24. Suggestions for improvement in the implementation of such activities in future.
    j. ……
    k. ……

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5 (l): TMR Machine

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. Provide the following details

Land holding area		Cattle, Breed ……			Buffalo, Breed …….			Goat
Khet (Kattha/ Ropani	Bari (Kattha/ Ropani	No. Milking	No. Non-milking	Total milk production, liter/day	No. Milking	No. Non-milking	Total milk production, liter/day	

7. When did you receive this machine (year)……
8. How much did you pay for this machine?.....
9. What was the actual price of the machine?.....
10. Capacity of TMR machine (Kg TMR production/hour)…….
11. Who owns the machine? (Individual/group/cooperative/firm), (√ as appropriate).
12. Have you got an operational manual for this machine (operation, repair and maintenance)? …….(Yes/No)
13. If yes, how useful is this? (very useful/useful/not useful), (√ as appropriate).
    Any remarks……
14. Is the machine operational (Yes/No)…….
    If Yes, move ahead from question **16.**
15. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
16. Forage production

	Species	Area cultivated (katha/Ropani)	Annual fodder harvested (kg)
Annual winter fodder	1. 2.	1. 2.	1. 2.
Annual summer fodder	1. 2.	1. 2.	1. 2.
Perennial fodder	1. 2.	1. 2.	1. 2.

17. TMR preparation per lot……kg,
18. Time taken to prepare per lot…….. hour

19. TMR production per day……kg

20. Feeding materials mixed in preparation of TMR

	Months (….. To ……)	Months (….. To ……)	Months (….. To ……)
- Rice straw, kg			
- Wheat straw, kg			
= Wheat bhusa, kg			
- Green fodder, kg			
- Commercial concentrate feed, kg			
- Maize flour, kg			
- Wheat bran, kg			
- Mineral mixture, kg			
- Common salt, kg			
- Other feed (specify)……..			
- Other feed (specify)……...			
- Other feed (specify)……...			
- Other feed (specify)…….			
Total, kg			

21. What roughage (*ghans, paraal*) do you buy from outside?

Feed stuffs	Quantity per year	Price per kg	From where?
Straw			
Bhusa			
Green grass			
Maize stover			

22. How is TMR fed?

	Milking animals	All classes of animals	Goats

TMR as sole diet (only diet)			
TMR mixed with ……kg of …… feeds			

23. Milk production (Increase/decrease/constant) compared to before TMR feeding.
24. Time required to make 100 kg TMR (hr per day)……..
25. Cost of electricity use per month, Rs…….
26. Annual cost of maintenance and repair, Rs……
27. Reasons for choosing TMR machine……
28. Did this meet your expectations (Yes/No)
    a. If yes, how?.....
    b. If No why?.....
29. Cost per TMR block preparation……Rs

30. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

31. Frequency of visits by extension service providers (number of visits per month)……..
32. Suggestions for improvement in the implementation of such activities in future.
    a. ……..
    b. ……
    c. ……..

Name of Enumerator…… Signature……..
Mobile number……..

Annex 5(m): UMMB machine

1. Date:……..
2. District……Municipality…… Village……
3. Name of farmer/group/cooperative/firm/GoN Office……..
4. Number of members if it is a group/cooperative……..
5. Name of contact person…… Contact number……..
6. When did you receive this machine (year)……
7. How much did you pay for this machine?.....
8. What was the actual price of the machine?.....
9. Capacity of UMMB machine (Number of blocks per day)……..
10. Is the machine operational (Yes/No)…….
11. If Yes, go to question **13.**
12. If No, give reasons why it is not in operation:
    a. ……..
    b. ……
    c. ……..
13. Number of blocks made per month…….
14. What is the composition of block (what is mixed)?

SN	Ingredients	Percent	Price per kg (Rs)
1	Urea		
2	Molasses		
3	……		
4	……..		
5	……		
6	……..		
7	……..		
8	……..		
9	……..		
10	……		

15. Number of blocks made by a person per day……
16. Daily labor wage (Rs/day)
17. Sale of blocks (by year for the last three years)
    Year 1…….. Year 2…….. Year3……..
18. Price of blocks per piece Rs/piece……
19. Who are the buyers:
    Names …….. Addresses……..
20. Average cost to make a block, Rs per piece……..
21. Income from selling blocks (annual)……..
22. Reasons for choosing UMB machine……
23. Did this meet your expectations?
    If yes, how?
    If not why?

24. Problems related to the UMB machine
25. Problems related to block feeding
26. In your practical experience, what is the real value of UMB?
27. Type of training received

S.N	Name of training	Duration	Who offered the training?	Percent of skills applied
1				
2				
3				
4				
5				
6				

28. Frequency of visits by extension service providers (number of visits per month)……..
29. Suggestions for improvement in the implementation of such activities in future.

Name of Enumerator…… Signature……..
Mobile number……..

A Glimpse of Machineries and Equipment Distributed under Forage Mission

Figure 1 Surendra Rai, Matshyagaon, Naikap, Kathmandu

Figure 2 Pokhara LIvestock Farm

Figure 3 Manmohan Adhukary, Archaleni, Sundar Bazaar 4, Lamjung

Figure 4 Rajendra Panta, Chyangli, Palungtar, Gorkha

Figure 5 Livestock Farm, Jiri, Dolakha

Figure 6 Raju Maharjan, Harsiddhi, Lalitpur

Figure 7 Sadhuram Dhungel, Manthali, Ramechhap

Figure 8 TMR Machine in Livestock Farm Pokhara

Figure 9 Multifunction chaff cutter, Livestock Farm, Pokhara

Figure 10 Seed cleaner cum grader in Nuwakot

Figure 11 Seed bins in Nuwakot