Breeding Strategy and Action Plan for Genetic Improvement of Livestock in Nepal

Nepal Livestock Sector Innovation Project
Ministry of Agriculture and Livestock Development
Government of Nepal

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July 2019

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Acknowledgments

The consultants thank all those who helped and shared their insights and knowledge to bring out this document. We would first like to thank Dr. Dilli Sedai, Project Director, who encouraged and supported us at every stage of our assignment and provided valuable suggestions. We also acknowledge the wholehearted support received from the NLSIP officers, Drs Jagat Bandhu Nepali and Sujan Rana, and the entire NLSIP team. Very special thanks are due to Dr. Prabhakar Pathak, Technical Team Leader, who gave his time whenever required to complete our tasks and participated in many of our discussions and offered valuable suggestions. We also gratefully acknowledge the support received from Dr. Prakash Mathema, Secretary MoALD and Coordinator of the Central Level DP and its members, Dr. Banshi Sharma, Director General, DLS, and his team and then Director General Dr Bimal Kumar Nirmal.

During the course of our field visits the chiefs of all four DLSUs of the NLSIP Dr. Ram Kumar Mandal (Biratnagar), Dr. Surendra Yadav (Hetauda), Dr. Purushottam Tripathy (Butwal) and Dr. Laxaman Dhakal (Pokhara) and their staff helped us in organizing the field trips and also accompanied us at many places. We also acknowledge their support in organizing the respective regional workshop. During our field visits, we met many members of milk producers' cooperative societies including their board menbers and also visited many dairy farms. These dairy farmers provided us a good insight into the existing dairy production systems and the challenges they face. We gratefully acknowledge their help. During our visits we also met officers of NLBO, Pokhara, LBO, Lahan, and LBO, Nepalganj who provided us a good understanding of the existing systems of semen processing and LN and semen distribution in the country. We gratefully acknowledge their help. Special thanks are also due to Dr. M. R. Garg and Dr. Chet Raj Upreti, the nutrition consultants, who constantly interacted with us and provided insights into the nutritional factors that hamper the genetic progress.

We would also like to thank all participants of the Central Level Validation workshop held at MoALD and also those of four state-level interaction workshops who provided us valuable suggestions on our draft report and improved our understanding of the dairy production sector.

We would also like to thank all those individuals who helped us generously but not mention here.

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Abbreviations

AI:	Artificial Insemination
BGIP:	Buffalo Genetics Improvement Programme
CBS:	Central Bureau of Statistics
CDCAN:	Central Dairy Cooperative Association Limited Nepal
DBIP:	Dairy Buffalo improvement Project
DCIP:	Dairy Cattle Improvement Project
DLS:	Department for Livestock Services
DLSU:	Decentralized Level Support Unit of the NLSIP
DMPCU:	District Milk Producers' Cooperative Union
DP:	Dialogue Platform
GDP:	Gross Domestic Product
LBO:	Livestock Breeding Office
LGIMC:	Livestock Genetic Improvement Management Committee
LGIU:	Livestock Genetic Improvement Unit
LMIS:	Livestock Management Information System
LN:	Liquid Nitrogen
LSS:	Livestock Service Section of municipality
MoALD:	Ministry of Agriculture and Livestock Development
MPCS:	Milk Producer Cooperative Society
NARC:	Nepal Agricultural Research Council
NLBO:	National Livestock Breeding Office
NLSIP:	Nepal Livestock Sector innovation project
PAS:	Project Appraisal Document
PDOs:	Project Development Objectives
PMU:	Project Monitoring Unit
POs:	Producers Organizations
PPRS:	Performance Recording and Pedigree Recording System
PSC:	Project Steering Committee
PT:	Progeny Testing
SOPs:	Standard Operating Procedures
VH&LSSC:	Veterinary Hospital and Livestock Specialized Service Centre

Chapter 1
Introduction

1.1 Background

The Nepal Livestock Sector Innovation Project (NLSIP) sought services of qualified and experienced experts in the field of animal breeding one from within and the other from a South Asian country having similar conditions like in Nepal to assess the breeding status of Nepal, prepare future strategies and a plan based on the assessment and develop an implementation plan including standard operating procedures (SoPs) to be followed for key activities proposed in the project. The project is financed by the World Bank and executed by the Ministry of Agriculture and Livestock Development. The project carries a total budget of USD 115 million of which USD 80 million is financed by the World Bank.

The Development Objectives (PDOs) of NLSIP are to increase productivity, enhance value addition, and improve the climate resilience of smallholder farms and agro-enterprises in selected livestock value-chains in Nepal. The Project has four components: (i) Strengthening Critical Regulatory and Institutional Capacity; (ii) Promoting Sector Innovation and Modernizing Service Delivery; (iii) Promoting Inclusive Value Chains for Selected Livestock Commodities; and (iv) Project Management and Knowledge Generation. The project is implemented across the mountains, hills and the Terai plains in four clusters along the road corridor encompassing five newly established States of the country. Under Component (ii) of the project, there is a focus on genetic improvement of cattle, buffaloes and goats with the objective of contributing to increased productivity and ultimately enhance the effectiveness of the value chain operations of livestock enterprises. The project commenced its field activities in 2018 and will terminate in the year 2023-24 AD.

1.2 Methodology adopted for the study

The study team first carried out the review of secondary information, studied the published documents, and drew lessons learned from the implementation of genetic improvement programs in the past. The key documents used in the assessment of the current status of genetic resources and the infrastructure of genetic improvement include: Livestock Statistics of Nepal 2016/17 (2073/74 BS), NLBO annual report 2018, and literature related to the Dairy Cattle Improvement Project (DCIP) and Dairy Buffalo Improvement Project (DBIP). The team made an extensive field visits in Kaski, Tanahun, Chitwan, Morang, Jhapa, Siraha, Makawanpur, Rupandehi, Syangja, Banke and Bardia districts and met many dairy farmers, artificial inseminators, employee, members and board members of many primary cooperative societies and district cooperative unions, staff of municipalities particularly managing Livestock Service Section/Centre (LSS/LSC) and district level Veterinary Hospital and Livestock Specialized Service Centre (VH&LSSSCs), and private entrepreneur engaged in providing services to farmers. The team organized four state-level and one national level interaction workshops. The workshops participants for the state level constituted State Level Stakeholder Dialogue Platform members and that for the national workshop National Level Stakeholder Dialogue Platform members. Besides, in all workshops, stakeholders from different segments of the industry and farmers were invited.

Based on the secondary information and the firsthand information received from many stakeholders, the team prepared an assessment report of the existing genetic resources and the infrastructure that exists for genetic evaluation and the production and dissemination of quality genetics. The team then set broad national annual targets for percentage breedable animals to be inseminated, a number of semen doses to be imported and produced locally, the number of bulls to be used for semen production, and the number of bulls required for replacement for the NLSIP period and ten years beyond the end of NLSIP. The three key documents used in this exercise were: Livestock Statistics of Nepal 2016/17 (2073/74 BS), the Livestock census of 2011 AD, and NLBO annual report 2018. Having made broad national targets, the team prepared a detailed strategic plan for production and dissemination of genetics both for cattle and buffaloes and for goats including identifying specific locations where and the institutions through which the proposed programs could be implemented. The strategic plan identified the role that women play in livestock breeds improvement programs and also the social and environmental issues in alignment with Environmental and Social Safety Measures (ESSM) of the World Bank and the Government of Nepal. The team then prepared a detailed implementation plan and identified roles and responsibility for all institutions and personnel involved. It also prepared Standard Operating Procedures (SoP) for key activities proposed.

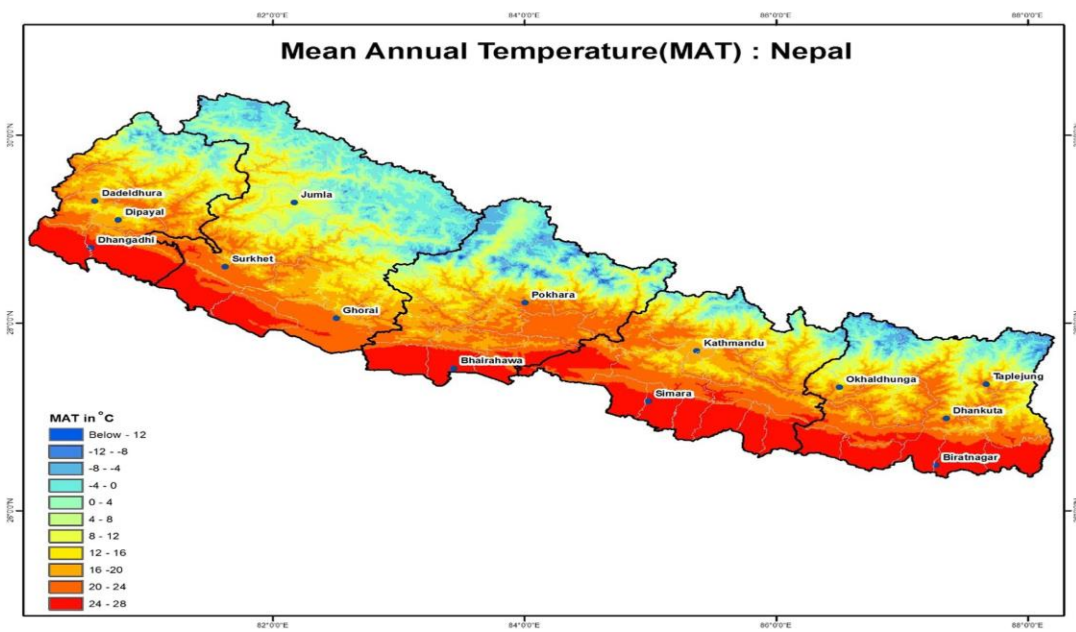
1.3 Structure of the report

This chapter provides general information on the country's physiographic regions, climate, human population, milk consumption and demand, and the economic importance of cattle, buffaloes, and goats in the country. Chapter 2 then describes in detailed the existing genetic resources of cattle, buffaloes and goats and the past trends of their number and production. Chapter 3 makes an assessment of the existing infrastructure and programs for the production and dissemination of genetics in the country. Chapter 4 makes a vision statement and develops a framework for the genetic improvement of cattle, buffaloes and goats in the country. Chapter 5 then attempts to set broad targets in terms of percentage of breedable cattle and buffaloes to be inseminated, the number of semen doses to be imported and produced locally, the number of bulls to be maintained for semen production, and the number of bulls required for replacement annually by the end of NLSIP period as well as by the end of the next 15 years. Taking these broad targets the chapter then proposes a strategic plan for genetic evaluation and production of genetics as well as for dissemination of genetics in the country. A similar broad framework has also been proposed for the genetic improvement of goats in the country. Chapter 6 prepares an action plan for the implementation of the proposed strategic plan including standard operating procedures for key activities. It also delineates the role and responsibilities of all institutions and personnel who would be involved in implementing the strategic plan. Besides, it estimates the human resource needs to implement all the identified activities and suggests a plan for their capacity building. Chapter 7 identifies certain key policy and legal aspects that need to be addressed for the smooth implementation of the breeding programs proposed. It also identifies the information needs of all stakeholders that would be involved in implementing various activities. Chapter 8 at the end summarises all recommendations. All SoPs developed for different activities are given as annexes.

1.4 Physiographic regions and climate

Nepal with an area of 147,181 sq. km. broadly has three physiographic zones, namely mountain, hill, and Terai. Though in three belts in a broad sense, the country has five distinct agro-physiographic regions from south to north, and with increasing altitude, these are (a) Terai, (b) Siwaliks, (c) Middle Mountains, (d) High Mountains, and (e) High Himalayas. These physiographic zones vary widely in their proportion of land use for agricultural purposes in general and livestock in particular. Mountain region in the north is located above 2,000 masl and covers an area of 51,817 sq.km. The snow line lies at around 2,500 masl in winter and 4,000 masl in summer. The climate varies from alpine, cool temperate to warm temperate depending on the altitude and aspects of the mountains (see Figure 1 and 2). Livestock in this region is raised mainly under the transhumance system.

Figure 1. Mean annual temperature in different physiographic regions in Nepal

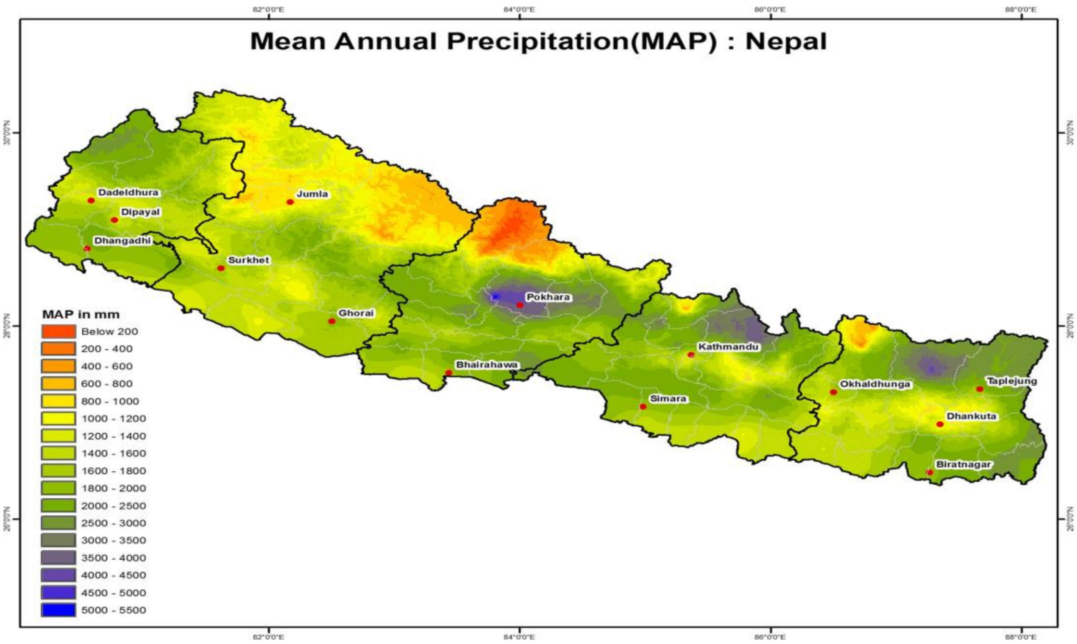


Source: Karki, RC, Talchabadel, Rocky, Aalto Juha and Baidya SK (2015). New climatic classification of Nepal. Theoretical and Applied Climatology. https://www.researchgate.net/publication/280034906

Hill region represents between 330 -2,000 masl altitudes and covers an area of 61,345 sq. km. It has around 42 percent of the agricultural land in which livestock are raised in an integrated crop-livestock farming system. The area is characterized by high ridges and steep slopes around numerous rivers and streams giving rise to many microclimates within hill region. Low lying areas and river basins have humid sub-tropical climate and hills and ridges have sub-tropical to the temperate type of climate. The *Terai* region represents the plain area in the south altitude ranging from 50 to 300 masl and has a subtropical climate. The season in Nepal can be divided into four types: (i) Winter (December-February); (ii) pre-monsoon (March-May); (iii) monsoon (June-September); and (iv) post-monsoon (October-November).

The average annual rainfall is about 1,600 mm, about 80 percent of which falls between June and September. The mean annual precipitation varies from more than 5,500 mm along the southern slopes of the Annapurna Himalayan range (Pokhara area) to the central part of the country to less than 250 mm (Figure 2) in the northern central portion near Tibetan plateau (rain shade area of Manang and Mustang). Most of the winter rainfall occurs from December to February.

Figure 2. Mean annual precipitation



Source: Karki, RC, Talchabadel, Rocky, Aalto Juha and Baidya SK (2015). New climatic classification of Nepal. Theoretical and Applied Climatology. https://www.researchgate.net/publication/280034906

Average precipitations and minimum and maximum temperatures in five zones and four seasons are given in Table 1. The lowest annual rainfall is in the High Himalaya zone; the remaining zones receive rainfall between 1500-1700 mm. The normal winter precipitation occurs between December and February. It decreases from the west to the east. The summer monsoon starts from early June in the eastern region and reaches the west by the middle of June. The summer monsoon precipitation is the lowest in the High Himalayas and the highest in the Siwaliks. Kaski, Sindhupalchok and Sankhuwasabha districts receive higher summer monsoon precipitation. The pattern is similar for the pre-monsoon and post-monsoon precipitation. During the summer monsoon, the humidity rises considerably with high temperatures.

The temperatures vary depending on the altitude, the highest being in the Terai region and the lowest in the High Himalayas. The annual average maximum temperature varies from 17.6^0 C in the High Himalayas to 30.3^0 C in the Terai region. All Terai districts and Surkhet, Tanahun, Sindhuli, and Udaypur districts have temperature more than 30^0 C. In some places in the Terai region in summer the temperature exceeds 44^0 C. Likewise, the minimum temperature varies from -3.8^0 C in the High Himalayas to 18.8^0 C in the Terai region.

Table 1. Average precipitation and temperature in Nepal

Zone	Precipitation (mm)					Maximum Temperature (^{0}C)					Minimum Temperature (^{0}C)				
	Winter	Pre-Mon.	Monsoon	Post-Mon.	Annual	Winter	Pre-Mon.	Monsoon	Post-Mon.	Annual	Winter	Pre-Mon	Monsoon	Post-Mon	Annual
HH	49.6	105.4	502.9	36.5	694.2	11.8	18.5	21.5	16.9	17.6	-9.1	-4.8	2.0	-5.5	-3.8
HM	72.6	202.7	1189.8	62.9	1527.9	11.8	18.5	21.5	16.9	17.6	-0.2	6.4	12.8	5.0	6.6
MM	60.2	212.9	1292.7	61.7	1627.4	18.6	26.8	27.8	23.9	24.6	5.8	13.6	19.4	12	13.3
Siwaliks	52.0	160.9	1426.3	69.4	1708.5	22.6	32.5	32.4	28.5	29.3	8.9	17.7	23.5	15.9	17.1
Terai	41.7	149.5	1339.1	70.2	1600.4	23.9	33.9	33.9	30.3	30.8	10.3	19.5	25.2	17.7	18.8

Source: Observed climate trend analysis of Nepal, Department of Hydrology, Nepal (2017). HH: High Himalayas; HM: High Mountains; MM: Mid Mountains.

Livestock production in a sub-tropical country like Nepal is greatly affected by the climate in two ways: first by direct influence on animal physiology, acclimatization and adaptation, and secondly by indirect effects on the environment – i.e. on the quantity and quality of the feed available for them and incidences of diseases and parasites. Considering these factors, the climate of the mid-mountain and high-mountain areas could be considered comfortable for dairy cattle and buffaloes of high grade, whereas in the other regions it could be considered very harsh. The districts in the High Himalayas region have severe winters, and the districts in the Terai region have severe summers.

1.5 Human population and sufficiency in milk

The human population of Nepal for the year 2019 was projected to stand at 29.71 million (Table 2; CBS 2014 projection). The next census collection is due in the year 2021 AD (2078 BS). Government of Nepal plans to raise milk production in the country so that per capita availability reaches 91.0 liter/annum. For the projection of milk production scenario, population figures projected under high variant scenario by Central Bureau of Statistics (CBS, 2014) are applied. Similarly, milk production base figure of FY 2016 - 17 (DLS, 2017) is used for projecting the milk production scenario. Growth rates that fit on demand side based on *per capita* income growth are assumed at 7 percent for the year 2019 and then at 8% thereafter. The production and demand projection based on these crude assumptions set a scenario that self-sufficiency in milk (@ 91.0 liters/person/annum) would be achieved in the year 2022 (Table 2). Achieving more than 8% growth in milk production in itself requires intensive and well-planned programs nationwide. It is anticipated that NSLIP will become one of the main investments to achieve this national goal through effective implementation of the genetic improvement program of dairy animals.

Table 2. Milk demand projection for the next ten years

Year	Projected Population (millions)	Req. of milk @ 91.25L/person /annum (mt)	Total production (mt)	Projected demand growth %	Deficit /surplus	Per capita availability L
2017	28.88	2635300.0	1911239.0	7	-724061.0	66.2
2018	29.29	2672712.5	2045025.7	7	-627686.8	69.8
2019	29.71	2711037.5	2188177.5	7	-522860.0	73.7

2020	30.12	2748450.0	2341350.0	8	-407100.0	77.7
2021	30.53	2785862.5	2528658.0	8	-257204.5	82.8
2022	30.93	2822362.5	2730950.6	8	-91411.9	88.3
2023	31.33	2858862.5	2949426.6	8	90564.1	94.1
2024	31.72	2894450.0	3185380.8	8	290930.8	100.4
2025	32.11	2930037.5	3440211.2	8	510173.7	107.1
2026	32.48	2963800.0	3715428.1	8	751628.1	114.4
2027	32.84	2996650.0	4012662.4		1016012.4	122.2

*Source: Calculated from DLS data, CBS (2014) and assumptions made for growth projections (*Per capita availability under constant population scenario of 26.5million).*

1.6 Livestock species of economic importance

Among the domesticated animal genetic resources, cattle including (*Bos Taurus, Bos indicus and Bos grunniens*) are the most numerous bovines followed by goats including Chyangra (*Capra hircus*), buffalo (*Bubalus bubalis*) and sheep (*Ovis aries*). Pigs and poultry are other economically important domesticated species well integrated into the Nepali farming system. Agriculture contributes about 28% to the total GDP of the country and the contribution of livestock to total AGDP of the country is estimated to be about 30% (Nepal economic survey 2017/18). Dairy contributes more than 60% to the total livestock GDP. Low productivity of livestock is one of the bottlenecks to commercialization and market-oriented livestock development. Crossbreeding is adopted at random as a means of a development initiative in cattle, buffalo, goats, and pigs. As a result, the purity of native types is being lost in some areas due to random and informal breeding programs and farmers' temptation for crossbreeding irrespective of the genetic potential of the native breeds, especially in goats.

The breeding programs necessitate two approaches, crossbreeding aimed at increasing productivity and promotion of commercial farming, and conservation programs to: (i) identify all genetic resources comprising the gene pool of species used as domestic livestock; (ii) develop and use the associated diversity to increase production, achieve sustainable systems and meet demands for particular products; (iii) monitor resources represented by small numbers or that are being displaced; and (iv) long-term preserve resources not in current demand.

As stated above, the altitudinal and climatic variation greatly influences the animal production systems, breeds, availability/supply of animal feed resources, breed adaptations and, therefore the productivity. In Nepal in general, most of the species irrespective of breeds compromise productivity level in the process of physiological adaptations in harsh climatic conditions. For example, HF crosses of high grade in Terai region appear stressed all the while during summer. This is one of the several reasons performance testing programs are essential before any gene specific to breed is subjected to mass dissemination. Selection of genetic resources should consider these factors while executing breed improvement programs in a physiographic location.

Chapter 2
Genetic Resources

2.1 Introduction

Nepal has a very diverse and large population of livestock. This chapter describes the existing resources of cattle, buffaloes, and goats based on the available secondary information, and the quick assessment made during our field visits. The chapter begins with providing a brief overview of the number and productivity of cattle and buffaloes and the diversity of the population in terms of breeds, their geographical distribution and the role they play. It then delineates briefly the production systems. The last section describes the genetic resources of goats, the production systems and the role they play in sustaining the livelihood of a large number of farmers in the country.

2.2 Cattle and buffaloes

2.2.1 Population and productivity

There are 7.35 million cattle of which 1.03 million are adult cows in milk. Likewise, there are 5.18 million total buffaloes and 1.51 million adult buffaloes in milk (MoAD, 2016-17). The average productivity of cows in milk is estimated to be 646 kg. per cow per year and that of buffalo 825 kg (Table 3). The total milk produced by cattle and buffaloes was estimated at 1.91 MMT, about 35 percent contributed by cattle and the remaining 65 percent by buffaloes. Besides, buffaloes contribute 60 percent to the country's total meat production.

Table 3. Population and productivity - 2016-17

Species	Total number in million	Adult females in milk in million	Average milk production per animal per year in kgs.	Contribution to total milk production in MMT
Cattle	7.35	1.03	646	0.665 (35%)
Buffaloes	5.18	1.51	825	1.246 (65%)

The cattle population in the last decade has increased at a compounded annual rate of 0.42 percent, whereas the population of adult cows in milk by 1.26 percent (Table 4). Though the average productivities of cattle and buffaloes are quite low, over the last decade the average productivity of cows in milk has increased quite significantly at an annual rate of 4.10 percent. In the case of the buffaloes, the total population of buffaloes and buffaloes in milk increased by 1.72 percent and 2.99 percent respectively; however, the productivity of buffaloes has almost remained constant over the last decade.

Province 4 has the lowest number of cattle, but the highest productivity in cattle (Table 5). Province 1 has the highest number of cattle; however, it stands at number 4 on the productivity level. In the case of buffaloes, Province 5 has the largest number of buffaloes, but it is ranked fifth on the productivity level. Province 6 has the lowest number of buffaloes and stands at the bottom on the productivity scale. Province 1 is contributing maximum to the country's milk production.

Table 4. Trend of the population of cattle and buffaloes

Year	Cattle	Milking cows	Buffalo	Milking buffaloes	Cow Milk in MT	Average yield per cow (kg)	Buffalo Milk in MT	Average yield per buf.(kg)
2006-7	7,044,279	908,712	4,366,813	1,124,454	392,791	432	958,603	853
2007-8	7,090,714	915,411	4,496,507	1,158,300	400,950	438	987,780	853
2008-9	7,175,198	932,876	4,680,486	1,211,495	413,919	444	1,031,500	851
2009-10	7,199,260	954,680	4,836,984	1,252,770	429,030	449	1,066,867	852
2010-11	7,226,050	974,122	4,993,650	1,291,644	447,185	459	1,109,325	859
2011-12	7,244,944	998,963	5,133,139	1,331,037	468,913	469	1,153,838	867
2012-13	7,274,022	1,025,591	5,241,873	1,369,796	492,379	480	1,188,433	868
2013-14	7,243,916	1,024,513	5,178,612	1,345,837	532,300	520	1,167,773	868
2014-15	7,241,743	1,025,947	5,167,737	1,345,164	587,719	573	1,168,006	868
2015-16	7,302,808	1,026,135	5,168,809	1,355,384	643,806	627	1,210,441	893
2016-17	7,347,487	1,029,529	5,177,998	1,509,512	665,285	646	1,245,954	825
CAGR	0.42	1.26	1.72	2.99	5.41	4.10	2.66	-0.32

Source: Statistical Information on Nepalese Agriculture, 2016-17, Ministry of Agriculture, Land Management and Cooperatives.

Table 5. Cattle and buffaloes and their productivity by province - 2016-17

Province	Cattle	Cows in milk	Bufaloes	Bufaloes in milk	Cow milk	Bufalo milk	Total Milk	Avg. prod. cows	Avg. Prod. Buf.
Province 1	1,944,216	274,972	841,533	231,280	176,065	208,775	384,840	640.3	902.7
Province 2	1,095,159	153,848	777,841	279,919	99,903	174,205	274,108	649.4	622.3
Province 3	1,097,368	150,707	887,088	255,050	107,357	250,581	357,938	712.4	982.5
Province 4	558,355	78,471	720,157	201,056	70,913	211,937	282,850	903.7	1054.1
Province 5	1,023,834	144,287	1,111,812	307,705	84,028	231,607	315,635	582.4	752.7
Province 6	608,128	79,189	309,169	86,037	34,957	52,057	87,014	441.4	605.1
Province 7	1,020,427	148,055	530,398	148,465	92,062	116,792	208,854	621.8	786.7
Total	7,347,487	1,029,529	5,177,998	1,509,512	665,285	1,245,954	1,911,239	646.2	825.4
Percentage to Total								Rank on productivity	Rank on productivity
Province 1	26.5	26.7	16.3	15.3	26.5	16.8	20.1	4	3
Province 2	14.9	14.9	15.0	18.5	15.0	14.0	14.3	3	6
Province 3	14.9	14.6	17.1	16.9	16.1	20.1	18.7	2	2
Province 4	7.6	7.6	13.9	13.3	10.7	17.0	14.8	1	1
Province 5	13.9	14.0	21.5	20.4	12.6	18.6	16.5	6	5
Province 6	8.3	7.7	6.0	5.7	5.3	4.2	4.6	7	7
Province 7	13.9	14.4	10.2	9.8	13.8	9.4	10.9	5	4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0		

Source: Statistical Information on Nepalese Agriculture, 2016-17, Ministry of Agriculture, Land Management and Cooperatives

The mountain districts have about 11 percent of the total cattle and 7 percent of the total buffaloes. The cattle and buffaloes are almost equally distributed between hill and Terai districts. The hill districts have about 44 percent of the cattle and 48 percent of the buffaloes, whereas the Terai districts have 45 percent of the cattle and 45 percent of the buffaloes. The cattle productivity in terms of milk yield is the highest in the Terai districts and the lowest in the mountain districts. In the case of buffaloes, productivity is the highest in the hill districts and the lowest in the mountain districts (Table 6).

Table 6. Cattle and buffaloes by region - 2016-17

Region	Cattle	Cows in milk	Bufaloes	Bufaloes in milk	Cow milk	Bufalo milk	Total Milk	Avg. prod. cows	Avg. Prod. Buf.
Mountain Region	831,044	115,405	376,344	103,747	53,196	75,273	128,469	461.0	725.5
Hill Region	3,275,489	448,431	2,544,978	726,160	285,219	637,243	922,462	636.0	877.6
Terai Region	3,240,954	465,693	2,256,676	679,605	326,870	533,438	860,308	701.9	784.9
Total Nepal	7,347,487	1,029,529	5,177,998	1,509,512	665,285	1,245,954	1,911,239	646.2	825.4
Percentage to total								Rank on productivity	Rank on productivity
Mountain Region	11.3	11.2	7.3	6.9	8.0	6.0	6.7	3	3
Hill Region	44.6	43.6	49.1	48.1	42.9	51.1	48.3	2	1
Terai Region	44.1	45.2	43.6	45.0	49.1	42.8	45.0	1	2
Total Nepal	100.0	100.0	100.0	100.0	100.0	100.0	100.0		

Source: Statistical Information on Nepalese Agriculture, 2016-17, Ministry of Agriculture, Land Management and Cooperatives

The top 15 districts in terms of total cows in milk, total buffaloes in milk and total milk production are given in Table 7. Top 15 districts with respect to cows in milk have about 41 percent of the total cows in milk, top 15 districts with respect to buffaloes in milk have about 42 percent of the total buffaloes in milk and the top 15 districts with respect to their contribution to the total milk production – cow and buffaloes together – is about 42 percent. In all, there are 27 districts. These 27 districts together contribute to some 61 percent of the total milk produced in the country. These districts could be considered as important districts for initiating a genetic evaluation programme.

Table 7 Contribution by top districts

Top 15 district with respect to cows in milk	Top 15 district with respect to buf. in milk	Top 15 district with respect to total milk productionin	Common Districts	
MORANG	SIRAHA	KAVRE	MORANG	SIRAHA
SUNSARI	SAPTARI	MORANG	SUNSARI	KASKI
JHAPA	KASKI	KAILALI	JHAPA	MAHOTTARI
SAPTARI	KAILALI	JHAPA	SAPTARI	DHADING
KAILALI	SUNSARI	NAWALPARASI	KAILALI	DHANUSHA
SARLAHI	KAPILBASTU	KANCHANPUR	SARLAHI	BARA
BANKE	NUWAKOT	KASKI	BANKE	RUPANDEHI
ILLAM	MAHOTTARI	SYANGJA	ILLAM	DANG
KANCHANPUR	DHADING	CHITWAN	KANCHANPUR	SYANGJA
SALYAN	BANKE	SUNSARI	SALYAN	CHITWAN
NUWAKOT	DHANUSHA	BARA	NUWAKOT	MAKWANPUR
KAVRE	BARA	MAKWANPUR	KAVRE	TANAHU
KAPILBASTU	RUPANDEHI	TANAHU	KAPILBASTU	
BAJHANG	KAVRE	RUPANDEHI	BAJHANG	
NAWALPARASI	DANG	SAPTARI	NAWALPARASI	
Contributes to total				
40.83	42.34	42.09	61.35	

NLSIP has selected 28 districts. These selected districts have about 44 percent of the total cows in milk and 47 percent of the total buffaloes in milk. Their contribution to the total milk production is about 52 percent (Table 8).

Table 8. Contribution of districts selected under NLSIP

Area/Province	NLSIP	Total Nepal	NLSIP coverage
Cattle	3,133,730	7,347,487	42.65
Cows in milk	447,861	1,029,529	43.50
Buffaloes	2,366,721	5,177,998	45.71
Buffaloe in milk	704,362	1,509,512	46.66
Cow milk	322,473	665,285	48.47
Buffalo milk	673,562	1,245,954	54.06
Total Milk	996,035	1,911,239	52.11
Avg. prod. cows	720	646	
Avg. Prod. Buf.	956	825	

2.2.2 Breeds of cattle and buffaloes

The genetic resources of cattle and buffaloes can be divided into two groups: crossbreds (of both cattle and buffaloes) – mainstream breeds, and native breeds. The crossbreds both cattle and buffaloes play an important economic role. They are the major suppliers of milk in urban areas of both the hill and Terai districts. The native breeds, on the other hand, play an important role in providing the needed drought power and organic manure apart from valuable animal protein in the form of milk for home consumption. There is no information on the number of animals of different breeds, as no breed census has been done. According to the estimates of the Ministry of Agricultural Development, about 16 percent of cattle and 36 percent of buffaloes are crossbreds (MoALD, 2017). The main native cattle breeds include: Lulu, Achhami, Pahadi, Khaila, Terai, and Siri, and the main native buffalo breeds include: Lime, Parkote, Gadi, and Terai. A brief description of these breeds is provided below.

Crossbred cattle: The crossbred cattle are mostly that of HF and Jersey breeds. The exact proportion of HF and Jersey crossbreds is not known, but the Jersey and HF crossbreds are believed to be in the proportion of 60 and 40. The dairy farmers in hill regions prefer HF crossbreds. More Jersey crossbreds are found as one comes down from the hill districts to that of Terai. Most of these crossbreds have a very high exotic inheritance, more than 75 percent, as subsequent generations of crossbreds (F1, F2, F3, etc.) have been bred with pure exotic semen of HF or Jersey. The semen station managed by National Livestock Breeding Office (NLBO) keeps pure HF and Jersey bulls and supply semen of pure HF and Jersey bulls for artificial insemination in the country. With the belief that crossing of Jersey crossbreds increases production in the resultant Jersey-HF crossbreds, many farmers are crossing their Jersey crossbreds with pure HF. Similarly, many farmers also believe that crossing of HF crossbreds with pure Jersey improves the reproductive performance of their resultant HF-Jersey crossbreds and often cross their HF crossbred with pure Jersey. So in the important dairy producing districts of the country one finds all types of crossbreds: high-grade HF crossbreds, high-grade Jersey crossbreds, high-grade Jersey-HF crossbreds, and high-grade HF-Jersey crossbreds.

Not much information is available on the field performance of crossbred cows in the country. While implementing the Dairy Cattle Improvement Programme (DCIP), some crossbred cows were milk-recorded. Uddhave et al.[1] (2016) analysed five years data of this project between 2008 and 2012 and reported 300 days milk yield of 2735 ± 38.7 kg. for high-grade Jersey crossbreds based on 327

[1] Addhave et al., Journal of Agricultural Sciences & Technology A6 (2016) 69-75.

observations, 3173± 55.2 kg. for high-grade HF crosbreds based on 165 observations, and 2948 ± 54.4 kg. for Jersey-HF crossbred based on 122 observations.

During our field visits, we visited a few farms in Kaski, Chitwan, Ilam, Jhapa, and Siraha districts. The herd size of the majority of crossbred farms visited in these districts varied from 8-20 cows and a few farms having just 2-3 cows. Farmers prefer HF crossbred cows over Jersey in the hill districts, whereas the preference tilts towards Jersey crossbreds in Terai districts. All crossbreds both in the hill and Terai districts were high-grade crossbreds having exotic inheritance more than 75 percent as crossbreds have been repeatedly bred with the semen of pure exotic breed HF or Jersey. The percentage of cows in milk varied from 60 to 75 percent. The average yields of crossbred cows in milk varied from 9 litres per day per cow to 16 litres. The average peak yield in HF crossbred varied.

Figure 3. Crossbred cattle in Nepal

from 20 to 26 litres and in Jersey crossbreds from 16 to 20 litres. The farms visited were well managed in general. If one analyses the current feeding and animal husbandry practices, it seems possible to raise the average productivity of the crossbreds by 25-30 percent with balanced feeding and adapting good animal husbandry practices. The farmers in these districts are relatively better of farmers and could be convinced to participate in systematic performance recording and genetic evaluation programme and helped to raise the genetic potential of their future progenies. With putting in place a systematic genetic evaluation programme in these districts, they can become a nucleus to provide good genetics for the entire country. High variability existing in the crossbreds animals could effectively be used for accelerating genetic progress.

Crossbred buffaloes: Crossbred buffaloes are mostly the crosses of Murrah breed. Some 36 percent of the total buffaloes or 1.9 million total and 0.54 million adult female buffaloes are considered to be Murrah crossbred buffaloes. Buffaloes are reared both in hill and Terai districts. Siraha, Saptari, and Kaski districts have maximum buffaloes. The average yield of crossbred buffaloes recorded under Buffalo Genetic Improvement Programme (BGIP) was 5.8±1.73 kgs., fat percentage 6.1±2, protein percentage 3.2±0.7 and SNF percentage 8.4±0.1 (NARC 2016). During the field visit in Kaski district, we visited a buffalo farm. The farm had 17 buffaloes, 11 of which were in milk. They were high-grade Murrah buffaloes. The average yield of 11 buffaloes was 8 kgs. The average peak yields of the buffaloes as reported by the farmer was 12 kgs per day. The price received by the farmer per litre of milk varied from NRs. 70-75, which was almost 50 percent higher than that of cow milk. We also visited a few smallholder buffalo farms in Siraha districts. The average yields of buffaloes reported by farmers varied from 7 to 10 litres per day. The average price received per litre of buffalo milk was NRs. 60, about 20 percent higher than that of cow milk.

Figure 4. Murrah crossbred buffaloes

district

Murrah buffalo farm at NLBO: The farm maintains 62 adult female buffaloes, 4 adult males, 75 heifers, 24 young male calves and 44 calves, in all 209 buffaloes. During 2017-18, herd calving percentage was 67 percent, age at first calving 49.5 months and inter-calving period 16.3 months. The average 305 days lactation yield for three teats was 1722 kgs. during 2015-16 and the estimated 305 days lactation yield taking the yield of four teats was 2297 kgs. (NLBO Annual Report, 2017-18). The average mortality of calves till the age of one year was about 7 percent. Average birth weight of male calves born during 2017-18 was 32.3 kgs and those of female calves 30.7 kgs.

Figure 5. Livestock Development Farm, Pokhara

Native breeds of cattle: The important native breeds of cattle include: Lulu, Achhami, Pahadi, Khaila, Terai, and Siri. These breeds provide required draught power for ploughing and other agriculture operations such as transport and threshing, needed organic matter and micronutrients through manure for crop production, fuel through dried dung, etc. A brief description of these breeds is provided below.

Lulu: This breed is found in the high altitude (2800 m to 4000 m above sea level) districts of Mustang and Manang. They are hump less small cattle with average adult body weight 125-150 kg., wither height 87 cm and body length 99.4 cm. Their body colour may vary from completely black to brown to gray to completely white and some with white spots. They have the ability to perform in a very harsh environment and low input conditions. They produce on an average 1-2 litres of milk per day and have lactation length of about 200 days. Their numbers are declining. Efforts need to be made to conserve and develop this breed in its native tract.

Achhami: The breed is found in Achham, Bajhang, Bajura and Doti districts of Nepal. It is one of the world's shortest cattle breeds. Like Lulu cattle, its coat colour varies from black to brown to gray to white, and also spotted black and white. Cow's average height is 88 cms at the wither and average weight of 150 kg. It gives 1-2 litres of milk daily for 200-220 days. They are useful draught animals in terrace agriculture. A programme needs to be developed for its conservation and development.

Pahari cattle: This breed constitutes the major cattle in hills and mountains. They are generally black in colour. They are hardy animals. Females are poor milk producers producing milk around a litre. Males are good draught animals and useful for hills and terrace agriculture.

Khaila cattle: They are found in hills and mountains of the far-west region. They have a black and white coat colour. Adult males are useful draught animals. Females produce 2-3 litres of milk per day.

Siri Cattle: They are hill cattle found in Ilam district. The coat colour varies from black to white. Females are good milk producers giving 4-5 litres of milk per day. They have the ability to survive and perform under harsh and low input conditions. It is bigger than Pahari cattle. Adult body weight varies from 250-300 kgs. Siri is a critically endangered breed in Nepal.

Terai cattle: They are found in the Terai region. They are mostly white and red in colour. Females are low milk yielder producing 2-2.5 litres per day. Males are good for both ploughing and haulage. They are in good numbers and not at risk.

In the different parts of Terai region, many zebu cattle breeds of the adjacent Indian plains such as Ponwar, Kherigarh, Bachaur, and Hariana are also found. Among these, Hariana is a very promising breed. Hariana males are very useful animals for ploughing and haulage and females are good milk producers. During our visit in Siraha district, we found many Hariana animals. We also visited a few farmers having good Hariana cattle. The milk production of Hariana cows of the farms we visited varied from 5 to 9 litres per day.

Yak, Nak and Chauri: They are cattle of mountains adapted to cold and high altitude above 3000-5000 meter sea level. They are found in the northern mountainous region of the country. The male Yak is referred to as Yak. The female Yak is called Nak. A female produced by crossing male Yak with female hill cattle is referred to as Chauri and a male produced through such mating is called Jhopkyos. A reverse crossing of cattle male to Nak is not common. Body colour varies from black to white with thick fur. The Yak, Nak, Chauri, and Jhopkyos are useful animals for transportation and meat. Chauries are better milk producers than Nak. They produce about a litre of milk per day. Cheese made from Yak milk is very popular. Jhopkyos are sterile. Churies and Hjopkyos can be found at a lower altitude than Yak and Nak. The number of Yak and Nak has been reducing drastically. Serious conservation efforts are required to prevent the reduction in their numbers.

Native breeds of buffaloes: The important native breeds of buffaloes include: Lime, Parkote, Gaddi, and Terai. A brief description of these breeds is provided below.

Lime: They are found in low and mid hills of Nepal. The coat colour is brown. They have small sickle shape horns. The body size is small; adult buffalos weigh about 400 kg. They are maintained in semi-stall feeding conditions. Females are average milk producers giving 3-4 litres of milk per day. They are meat-type animals. Their contribution to improving soil fertility through manure is considered valuable. The breed is not at risk. Their number is still very high.

Parkote: They are found in the hills of Nepal. They are dark black in colour. Their horns are sword-shaped. They have a medium-sized body, adults weighing around 400 kg. They are maintained either under semi-stalled or migratory systems. Females are average producers giving 3-4 litres of milk per day. They have been crossed with Murrah and Lime breeds, but still, their number is high and the breed is not at risk.

Gaddi: They are found in the far western hill region of Nepal. Mostly they are black in colour. They have semi-curved horns like in Murrah breed. Females are average milk yielders; yields vary from 2 to 5 litres per day.

Terai: They are considered non-descript buffaloes found in the Terai districts of Nepal. They are in large numbers. They have been crossed with Murrah breed.

2.2.3 Production systems of cattle and buffaloes

The animal production systems in Nepal could be grouped into three systems: (i) Transhumant migratory system; (ii) Semi-migratory or semi-stationary system, and (iii) Stationary stall feeding or closed intensive farming system.

Transhumant migratory system: In this system farmers in summer between June and September take their animals – Yak, Nak, Chauries, Chyangra goats and Bhyanglung sheep - to upper mountain pasture for grazing and in winter bring them down and use lower altitude pastoral, forest and cropped areas around villages. This practice of taking animals to upper mountains in summer helps them to avoid the heat of low land and provides them an opportunity to make the use of upper mountain summer pasture on the one hand and of bringing down their animals in winter helps them to avoid the winter cold of upper hills as well as the winter scarcity of fodder of upper hills on the other. Yak, Nak and Chauries are mainly used for transportation and whatever milk they produce for making cheese and *chhurpi*. They also provide meat and manure. Sheep are used for producing wool, meat, manure and pack purposes. Similarly, goats are used for meat, manure and pack purposes.

Semi-migratory or semi-stationary system: In the hill region, in this system during winter at night animals are kept in the shed and during day time taken for grazing in common grazing land or in cultivated areas for fertilization. In summer, lactating, pregnant and sick animals are kept in the sheds and dry animals are taken to high pasture area as migratory type. In the Terai region, in this system, the animals are kept in the shed during the night and are taken out in the forest for grazing during day time. The valuable animals like lactating and pregnant animals are usually kept in the shed and managed. Cattle are mainly used for milk, draught, and manure. Sheep are mainly used for wool and meat purposes. Goats are used for meat and manure.

Figure 6. Semi-stationary production system in Terai region.

Stationary stall feeding or closed intensive farming system: Here, animals are kept in the sheds day and night and are fed and milked in the shed. This system is practiced by farmers in and around urban and suburban areas. They keep high grade crossbred cows and high grade crossbred buffaloes. Many farmers particularly having good market also grow cultivated fodder and multipurpose fodder trees and feed their animals a balanced ration. The farmers in dairy pocket areas have been following this production system.

Figure 7. Stall-fed production system

2.3 Goats

2.3.1 Introduction

History indicates goat (*Capra hircus*) has been domesticated since 8,000- 10,000 years ago and were first raised in the mountainous areas of the western part of Asia. While domestication, as people migrated with their animals to different locations, a number of morphological and physiological modifications occurred in the animals that led to evolution of different breeds and sub-breeds. The different breeds of goats (e.g. Khari of hill region and *Chyangra* goat of high-altitude) of Nepal are the results of such evolutionary adaptive modifications. The economic importance of this species is growing mainly by wide recognition of commercial possibilities for meat production, cashmere production, strengthening rural economy and supplying cash in need to families for meeting essential family expenditures. Goats are primary means of livelihood of smallholders of remote areas of Nepal where other entrepreneurial opportunities for income generation are limited and farming prevails in all the three agro-ecological regions of the country. .

2.3.2 Goat population

The total goat population of Nepal is about 11.6 million (Table 9). About 2.8 of the 5.6 million households keep goats. The share of goat and *Chyangra* is about 12% to the total livestock GDP and 17% to total meat production of the country (Table 10).

Khari is the predominant breed that constitutes about 50% of the total population; Terai goats about 9%, Sinhal about 10% and the rests are crossbreds of exotic breeds like Jamunpari, Barbari, Sirohi and of recently introduced Boer breeds. The exact number by breeds are not yet established and documented. A crude estimate indicates that Chyangra goats located in high altitude constitute less than 1% of the total goat population (<100,000 heads).

Table 9. Goat population by states and physiographic regions ('000)

States/Physiographic region	High Mountain	Hills	Terai	Total
State 1	345.8	1146.5	953.2	**2445.5**
State 2	0.0	0.0	1601.2	**1601.2**
State 3	374.9	1703.9	214.0	**2292.8**
State 4 (Gandaki)	42.4	1002.3	123.1	**1167.8**
State 5	0.0	956.1	1182.2	**2138.3**
State 6 (Karnali)	272.2	581.8	0.0	**854.0**
State 7 (Sudurpaschim)	257.2	527.6	294.3	**1079.1**
Total	**1549.7**	**644.6**	**306.1**	**11578.7**

Total goat meat consumption exceeds 20% the country, if the meat from imported goats is included in the calculations. Some 500,000 live meat goats are imported annually.

Table 10. Meat production scenario and contribution of goat meat to total

Species	MT.	% contribution
Buff	180080.0	54.2
Goat meat	57268.0	17.2
Pork	24535.0	7.4
Poultry	67706.0	20.4
Sheep	2714.0	0.8
Duck	241.0	0.1
	332544.0	

Per capita availability of meat is about 11.6 and the same for goat is about 2.0 kg (based on projected human population for the year 2019).

The first 20 districts having the highest number of goats are given below. Of the top 20 districts , 11 are NLSIP project locations.

Table 11. Top 20 districts with highest number of goats

Morang	399870	Bara	280762	Rupandehi	234639	Chitwan	213968
Nuwakot	371544	Jhapa	258890	Surkhet	234183	Bardia	209438
Kavre	301882	Udayapur	247630	Dhanusha	229733	Syangja	208651
Sunsari	294392	Sarlahi	246277	Sindhuli	225080	Saptari	200916
Makawanpur	294024	Dang	237444	Mahottari	214701	Banke	199265

2.3.3 Goat breeds and breeding

There are some 351 goat breeds in the world of which 146 breeds are recognized in Asia[2]. In general, goat genotypes were evolved and given name as breeds on the basis of their functions (meat, dairy, fur), locations (e.g. Asian, European, Terai, Ajmeri, Rajasthani, Jamunapari), body size (large, small, dwarf) and morphology (e.g. pendulous ear). Goat breeds are described as large, small or dwarf. The breeds with wither height of more than 65 cm and body weight between 20 – 63 kg are referred as large breeds; wither height between 51 – 65 cm and body weight between 19 – 37 kg as small breed; and body weight between 18 – 25 and wither height less than 50 cm are known as dwarf breeds. Nepali farmers and consumers prefer larger breeds.

Figure 8. A *Khari* doe with its quadruplet kids

Nepal has four distinct goat breeds (*Terai, Khari, Sinhal and Chyangra*) with possibility of existence of some other breeds or strains (e.g. Black Bengal like small goat breed of east Nepal), these four breeds have been registered with FAO's inventory of World Animal Genetic Resources. A brief description these four breeds of goat is given below.

Khari: This is the most predominant breed mainly distributed in the midhills of Nepal. Khari goats are the principal goat breed of the country and are found across the hills and inner valleys in the country. They are prolific and good for meat purpose. They are hardy and well adapted to local environments. They have been characterized at phenotypic level only. The wither height is ranges between 53 to 63, thus falling under large breed. Seven different color variants of this breed have been identified with the dominance of black or brown color. The horns are medium sized, cylindrical and pointing straightway backward and slightly upward (Figure 8). This breed is the most prolific among the native breeds of goats of Nepal (the doe in the picture had quadruplet kids, all four healthy and growing well.) and can adapt well to subtropical to temperate climatic conditions.

Figure 9. Variants of Terai Goats. Photo K P Paudel, NLSIP

[2] Devendra C. (1998). Indigenous goat genetic resources: potential importance in sustainable agriculture. Proceedings of the Fourth Global Conference on Conservation of Domesticated Animal Genetic Resources held in Kathmandu, on August 17-21,1998, NARC and Rare Breeds International Khumaltar, Lalitpur, Nepal

Terai breed: Terai goat constitutes about 9% of the goat population of Nepal and distributed in southern terai belt. Terai goats are located in terai region and inner valleys (tropical and sub-tropical climate) of the country and are meat type animals. They are heavily crossed with Indian breeds (Jamnapari, Barbari, and Beetal) and it is difficult to find pure line of Terai goats as they are subjected to immense changes through crossbreeding with long ear Indian breeds.. They display a wide range of variation within the breeds. Coat color vary from black, white brown, brown mixed with red, black with white marking, ash color. This breed is also known for its high prolificacy.

Sinhal Breed: Sinhal are the goats located in the southern aspects of high hills and high Himalayan

mountains between the elevation of 1500 to 3000 masl.

These goats are generally kept in a migratory flock with Baruwal sheep. The average adult body weights of male and female is 42 and 35 Kg respectively with an average wither height of 67 cm, therefore is a good breed for meat and transportation as pack animals. They are large sized hardy and well adapted animals to local harsh conditions. This breed is considered less prolific, therefore, not a priority breed of farmers in recent times. They are generally black, white , brown ar mixed type in color (figure 10).

Figure 10. A Sinhal goat. Source: ANGR report 2004, FAO.

Figure 11. A chyangra goat, note the scarce pasture it thrives on

Chyangra: *C*hyangra goats are reared in Trans-himalayan region along with Bhyanglung type of sheep in high-mountain above 2500 meter above sea level. They have been reared in situ condition by farmers themselves. They are suitable for meat, pack and *pashmina* (cashmere) production. Their population is declining and hence need attention. The peculiarity of this breed is twisted horns. They have spirally coiled horns that are scimitar typw heteronymoius as well as homonymously twisted. They have cosrse and slilkyu outer long hairs reaching down to knees and uder neath this outer coat they have fine undercoat of Pashmina or also called Cashmere. Most of Chyangra are black or white with white stripes in on the face, though other colors are also prevalent.

2.3.4 Production and productivity

Scale of production, productivity and profitability are the key to sustainable production and commercialization. Productivity including reproductive and growth performance of Nepali goats irrespective of the breeds is low (Table 12). Commercialization, competitiveness and modernization for growth of goat production system is greatly constrained due to non-availability of good quality seed animals within the country. Organized farms are non-existent that follow a herd performance recrods for production of replacement stocks.

Table 12 Productivity parameters of Nepali goats

Productivity Parameters	**Under research station**		**Under Farmer condition**	
	Goat*	***Chyangra***	**Goat**	***Chyangra***
Birth weight (Kg)	3.23	2.5	2	1.9
Weaning weight @ 4 month (Kg)	16.37		10	9.5
Six-month weight (Kg)		NA	13	11
Adult weight (Kg)	42	NA	28	25
Age at first service (days)	250	NA	300	405
Pregnancy period (days)	150	NA	150	148
Litter size at birth	1.66	NA	1.37	1
Twinning (%)	65	NA	37%	0
Litter size at weaning	1.56	NA	1.22	0.7
Kid mortality (before 4 month) %	<10	NA	10%	30%
Kidding/lambing interval (days)	250	NA	345	380
Number of animal off taken/100 does/ewes			64	42
Income /100 does/ewes flock NRs ‘000	NA	NA	640	580
Net profit/100 does/ewes flock, NRs ‘000 (self employed model)	NA	NA	520	400

Source: adapted from HIMALI (2018).Study on sheep and Chyangra goats of Nepal, HIMALI Project, DLS

The rapidly declining breed of goat appears to be Chyangra followed by Sinhal. Outmigration of youths has posed a hiatus in continuation of the conventional vocations of *Chyangra* farming. The carrying capacity and productivity of pastureland is too low; most people are discouraged in Chyangra goat farming due to demotivating rules and regulations of the Protected Areas (PAs). Moreover, opportunities of utilization of rangeland and pastures of downstream areas are declining due to community forest issues. The *Chyangra* goats are less productive, delivery of inputs and services is weak, adoption of modern technology is minimal, there are huge losses due to diseases and predation, market systems are almost non-existent, entrepreneurial investments and management skills of enterprises are minimum. The existing Chyangra goat farms are managed by hired herders and there is huge gap in knowledge and skill transfer among who owns the farm and who runs or manages it. For example, the herders in Manang districts were basically from Gorkha districts. Similarly, the herders of Mustang districts were from Myagdi and Baglung districts[3]. The entire production cycle is run in a natural way as it happens without much planning for investment for improvements. The production cycle is operating in spontaneity and all the events, accidents, animal deaths or losses and deviations in production and productivity are considered as usual occurrences and inevitable, therefore, are easily accepted as **“**It happens; we have to bear with it**”** mentality, as if there are no remedies.

[3] A study on Sheep and Chyangra goat in high altitude districts. Himali Project DLS

Chapter 3
Assessment of the Current Status of Genetic Improvement of Dairy Animals

This chapter first assesses the existing situation of performance and pedigree recording and genetic improvement programmes, semen production, liquid nitrogen production and procurement, semen and liquid nitrogen distribution, and AI delivery services in Nepal and offers suggestions for the establishment of a long term sustainable genetic improvement of cattle and buffaloes in the country. In second part, it assesses the breeding practices and infrastructure for goat breeding in the country.

3.1 Cattle and buffalo

3.1.1 Performance recording and genetic improvement programmes

At present, there is no performance recording and genetic improvement programme in place for any breed in Nepal. The bulls used for artificial insemination are not evaluated. A pilot technical cooperation project (TCP/NEP/3105) for performance and pedigree recording referred to as Dairy Cattle Improvement Programme (DCIP) was initiated with the assistance of the Food and Agricultural Organisation (FAO) in July 2008 for two years with the objectives to: (i) Identify superior cows based on their milk and milk component yields and inseminate them with imported semen to produce the next generation of young bulls to be used for artificial insemination and natural service for the entire country; (ii) Establish a system of genetic evaluation of bulls; (iii) Advise farmers on management of their animals based on performance records to improve their productivity and enhance income; (iv) Compare the performance of breeds and their crosses both to decide on a breed that performs best in given agro-climatic conditions and resource availability and also to help in developing future breeding strategies for Nepal; (v) Establish breed associations for supply of quality animals of respective breed; and (vi) Organise programmes for capacity building at all levels.

The programme was initiated at four locations one each in Kathmandu, Kaski, Chitwan and Rupandehi districts. Some 600 herds and 2500 cows were included in performance recording. Four Lacto-scan milk component testing equipment one each at National Agriculture Research Council (NARC) Kathmandu, National Livestock Breeding Office (NLBO), Pokhara, District Livestock Service Office, Chitwan, and District Livestock Service Office in Rupandehi were installed to carry out milk component analysis of samples received from the field. The analysis of data of this project for the period between 2008 and 2012 indicated that 300 days milk yield of high-grade Jersey crossbreds was 2735 ± 38.7 kg. based on 327 observations, 3173± 55.2 kg. for high-grade HF crossbreds based on 165 observations, and 2948 ± 54.4 kg. for Jersey-HF crossbred based on 122 observations (Uddhave et al., 2016). About 5000 semen doses each of Holstein and Jersey breeds were imported from New Zealand for production of young calves for AI and natural service. Unfortunately, the programme could not be continued after two years and it was terminated.

Some of the challenges that the project had to address are: (i) a large scale sales/movement of animals; (ii) number of herds that could be included in the programme; (iii) disposal of male calves; (iv) small and scattered herds; (v) difficulties faced in early morning milk recording; difficult terrain; a large turnover of milk recorders; (vi) timely flow of records; (vii) incomplete filling of formats; (viii) mismatching herds and animal identifications; (ix) maintenance of milko-scan; often the cost of maintenance is exorbitant; (x) delay in sending feedback to farmers; (xi) conflict of interest among technicians; (xi) reading bull ID number on straws; (xi) frequent strikes and road blockade; (xi) FMD outbreaks, etc.

The key lessons learned include: (i) all stakeholders are convinced that some kind of dairy improvement programme is absolutely necessary for Nepal; (ii) the benefits of genetic improvement programmes accrue after a long period of sustained efforts and hence such programmes should be planned for a long period of time; (iii) genetic improvement programmes, in the beginning, are public goods in nature and need to be supported by public funding; (iv) commitment of all stakeholders including farmers is necessary for successful implementation of genetic improvement programmes; (v) appropriate supervisory systems need to put in place to ensure high quality of data; (vi) a strong functional linkage is necessary between a research organisation and a project implementing organisation; (vii) some well-run cooperatives could be involved both for delivering AI services and milk recording; (viii) strong genetic improvement component needs to be added; and (ix) AI needs to be extended in non-descript cattle and buffaloes.

When the genetics of selected bulls is widely disseminated through the production of replacement heifers under artificial insemination system, it is imperative that the bulls used for semen production are genetically evaluated. It may also not be a prudent strategy to produce young bulls for semen production solely using top quality imported semen, as there may be genotype-environment interaction and the bulls produced using imported semen may not come out to be better than the bulls produced using top selected bulls proven locally when both the set of bulls are tested based on their daughter performance in Nepal. A wise strategy, therefore, would be to put a mix of bulls produced using both imported semen and semen of top locally proven bulls under test and select top bulls for production of young bulls for AI and natural service based on their daughter performance in Nepal. It is therefore necessary to develop an effective performance and pedigree recording system both for testing a certain minimum number of bulls in a few select pockets in the country where the best genetics of respective breed exists and for providing advisory services to farmers to ensure that the participating animals are managed under reasonably good management practices to express fully their genetic potential.

3.1.2 National Livestock Breeding Office

At present, there is one functional semen station at Lampatan, Pokhara under the National Livestock Breeding Office (NLBO) of the Department of Livestock Services (DLS) under the Ministry of Agriculture and Livestock Services (MoALS). This office, earlier named as National Livestock Breeding Centre, was shifted from Khumaltan to the current location in 2001-2. NLBO at Lampatan has a semen station, a liquid nitrogen plant, a livestock development farm, and a fodder farm. The infrastructure created and the activities carried out at NLBO are briefly described below.

3.1.2.1 Infrastructure for Semen Production and Processing

NLBO has nine hectares of land. Three hectares of land is used for building and sheds, and other six hectares for fodder production.

There are four bull sheds for cattle and buffaloes to maintain 37 bulls and a buck shed to maintain four bucks. It has spacious functional semen collection arena and adequate semen processing facilities to process more than 5 million doses. It has a liquid nitrogen plant.

The four bull sheds have varying capacity: Bull Shed I has the capacity to maintain five bulls, Shed II and III each have the capacity to keep 12 bulls, and Shed IV has the capacity to maintain eight bulls. The bull sheds of cattle and buffaloes are quite old. The pipelines enclosing bullpens are corroded. The space within the shed is not adequate for the free flow of material. The rooftop is closed and there is poor ventilation at the top for the free flow of air. The entire floor surface of the individual bullpen is solid and made of concrete (Figure 12).

Figure 12. Bull shed I at NLBO

The floor of the entire semen collection arena is hard and made of concrete (Figure 13). The semen processing laboratory is spacious and has the required equipment to process more than five million doses (Figure 14).

There is a buck shed to keep four bucks very close to the last bull shed (Figure 15) . There is a functional liquid nitrogen plant which is used whenever there is a shortage of liquid nitrogen from other industrial sources.

Figure 13. The semen collection arena

Considering the future requirement, a new modern bull shed to maintain 20-30 bulls with adequate space for delivery of feed and fodder with tractor, high roof with good ventilation, bullpens with one part having hard surface and another part having a soft loafing area may be built to house the additional bulls that need to be maintained at NLBO. The semen collection arena may also be modernized with one half having a hard surface and other half having a soft surface. From the biosecurity perspective, the buck

Figure 15. The buck shed

Figure 15. Interior of semen processing lab.

shed could be shifted a little away from the existing cattle sheds and the main bull shed area and the collection arena could be cordoned of making it totally bio-secured with restricted (or no) entry.

3.1.2.2 Bull procurement and production of semen doses

During 2017-18, the semen station of NLBO had 31 bulls under semen collection and produced in all 6.68 lakh doses at an average of 21,867 doses per bull. Of the total 31 bulls, 11 were of Jersey breed, 7 of HF breed and 13 of Murrah buffalo breed. Likewise, of the total production of 6.68 lakh frozen semen doses, 51 percent were of Jersey breed, 34 percent of HF breed and 15 percent of Murrah breed. The average number of semen doses produced per bull for Jersey, HF and Murrah were 31,091, 32,389 and 7,663 respectively. In the last decade, the production of semen doses increased remarkably by an annual compounded growth rate of 18 percent and that of average semen doses production per bull by 11 percent (Table 13 & Figure 16).

Table 13. Trend of semen doses production

Particulars/Year	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Jersey:											
Number of bulls under collection	10	8	11	8	9	10	10	10	10	10	11
Doses produced	99,613	119,954	140,151	167,464	186,861	184,943	222,062	254,090	250,876	321,364	337,117
Average doses produced per bull	9,961	14,994	12,741	20,933	20,762	18,494	22,206	25,772	25,912	32,553	31,091
Holstein Friesian:											
Number of bulls under collection	0	0	4	4	8	11	11	12	11	11	7
Doses produced	0	0	11,081	44,249	75,701	139,954	159,344	233,222	237,471	223,610	223,489
Average doses produced per bull	0	0	2,770	11,062	9,463	12,723	14,486	19,713	22,298	20,592	32,389
Murah:											
Number of bulls under collection	6	4	3	5	7	12	13	10	8	13	13
Doses produced	23,319	19,109	10,090	38,747	56,075	75,576	116,723	129,858	108,658	93,140	98,193
Average doses produced per bull	3,887	4,777	3,363	7,749	8,011	6,298	8,979	13,171	14,029	7,258	7,663
Total:											
Number of bulls under collection	16	12	18	17	24	33	34	32	29	34	31
Doses produced	122,932	139,063	161,322	250,460	318,637	400,473	498,129	625,983	616,634	646,394	668,341
Average doses produced per bull	7,683	11,589	8,962	14,733	13,277	12,136	14,651	19,837	21,940	19,255	21,867
Proportion of semen doses produced											
Jersey	81.03	86.26	86.88	66.86	58.64	46.18	44.58	41.17	42.02	50.36	51.17
Holstein Friesian	0.00	0.00	6.87	17.67	23.76	34.95	31.99	37.79	39.78	35.04	33.92
Murrah	18.97	13.74	6.25	15.47	17.60	18.87	23.43	21.04	18.20	14.60	14.90
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: NLBO Annual Report 2017-18

Many bulls have been used for semen production for a long period of time. As a consequence, the annual replacement rate of bulls is very low. Out of the 31 bulls under collection during 2017-18, two bulls had been used for nine years for semen collection, four for seven years, seven for six years, one for five years and the remaining 17 for less than five years. At least 25 percent of bulls under collection should be replaced by young bulls of higher genetic merit than the bulls under collection every year to ensure a reasonable level of genetic progress.

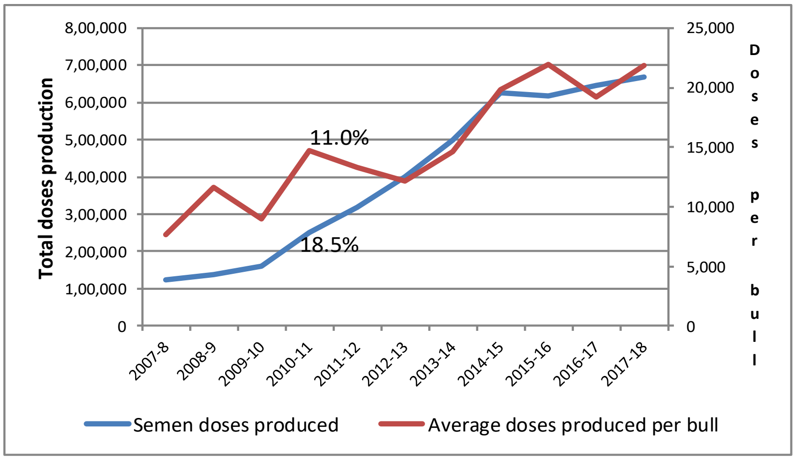


Figure 16. Trend of the total production of semen doses and average production per bull

3.1.2.3 Import of semen doses

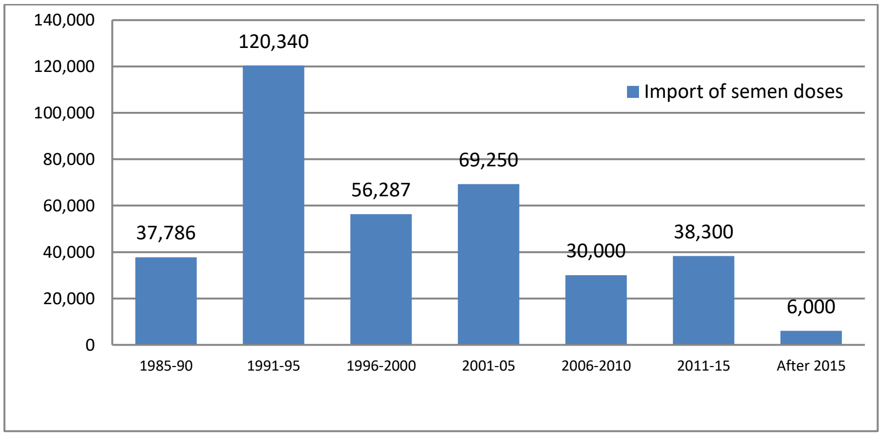
NLBO has imported frozen semen doses of cattle breeds primarily Jersey and HF and in small numbers Brown Swiss, Ayrshire, Tanentaise, and Hariana from various countries viz. USA, New Zealand, Finland, Germany, Canada, France, Italy and India and that of buffalo breeds mainly Murrah breed from India. Since 1986, some 288,273 doses of cattle including 9,000 sexed semen doses (mainly Jersey 54% and HF 18%) and 69,690 doses of buffalo (about 20%) have been imported (Table 14; Figure 17). If one takes cumulative figures of semen production and semen import since 1993-94, the import constitutes about 15 percent of the total domestic semen production. If one assumes that the current inventory of semen doses of different breeds is in proportion to their usage for AI in the field, it could be inferred that roughly 15 percent of semen doses used in the last 25 years for AI in the country are imported doses.

Table 14. Import of semen doses

	1985-90	1991-95	1996-2000	2001-05	2006-2010	2011-15	After 2015	Total	% to Total
Cattle:									
Jersey	10,000	52,000	33,517	65,350	10,000	18,450	3,000	192,317	53.7
Brown Swiss	14,786	7,000	0	0	0	0	0	21,786	6.1
HF	11,000	23,340	9,000	0	10,000	11,450	0	65,790	18.4
Ayrshire	2,000	0	0	0	0	0	0	2,000	0.6
Tarentaise	0	0	1,380	0	0	0	0	1,380	0.4
Hariana	0	0	0	0	5,000	0	0	5,000	1.4
Cattle Subtotal	37,786	83,340	43,897	65,350	25,000	29,900	3,000	288,273	80.5
Buffalo:									
Murrah	0	37,000	12,390	3,900	5,000	8,400	3,000	69,690	19.5
Cattle & buffalo	37,786	120,340	56,287	69,250	30,000	38,300	6,000	357,963	100.0

Source: NLBO Annual Report 2017-18.

Figure 17. Import of semen doses



3.1.2.4 Quality of bulls used for semen production

All the bulls used for semen production are either imported or produced locally by inseminating recorded females by imported semen except one Jersey bull which is produced by using semen of local bull. Table 3.3 provides the pedigree details of all bulls used for semen production during 2017-18. Though dam's yield alone does not reflect on the genetic transmitting ability of its bull calf, the average dams' yield of bulls indicate that some better-producing cows have been used for the production of bull calves. The average lactation yield of Jersey crossbred cows was 4164 kgs, HF cows 6187 kg. and Murrah buffaloes 3667 kg. (Table 14). However, while deciding on the import of bulls more attention could have been given on the selection of bulls. Six of 11 Jersey bulls used for semen collection are sired by the same US bull. In the case of HF, although all the HF bulls used for semen collection are sired by different bulls, the source of the imported bulls for 5 of 7 bulls is only one country that is New Zealand. In the case of buffaloes, four bulls out of 11 bulls imported from India have no information on sires and likewise, two bulls produced locally have no sire information.

Breed	No. of bulls	Average lactation yield bulls' dam (Kg.)	Bulls' sire
Jersey	11	4164	6 bulls sired by US bull 7JE 7859 1 bull sired by US bull 305054 1 bull sired by NZ Bull 103085 1 bull sired by local bull PJ46 2 are ET born
Holstein Friesian	7	6187	5 bulls sired by 5 different bulls from New Zealand 1 bull sired by local bull PJ3 1 bull has no information
Murrah	13	3667	2 bulls produced locally with no sire information 4 bulls imported from India with no information about sires 5 bulls imported from India with sire ID and sires' dam yield 2 Bulls have no information

Table 15. Pedigree details of bulls used for semen production during 2017 - 18

It is important that when the semen doses are imported for the purpose of producing bull calves, the bulls are sourced from more than one country, the required doses are divided among as many bulls as possible, the bulls whose semen doses are imported are currently active bulls in exporting countries, and have high breeding or genomic breeding values for production and reproduction traits and not very unfavourable for type traits. It is equally important that the bull calves produced from imported semen are put under a test program along with bulls produced using semen of best local bulls (or top locally proven bulls) to make a rational decision on the import of semen doses in the future. It is imperative therefore that a sustainable system of performance and pedigree recording and genetic evaluation through systematic progeny testing is established to select bulls that perform best under local conditions of Nepal and it is ensured that progressively better and better quality bulls generation after generation are used to achieve steady genetic progress in the local population.

3.1.3 Livestock Breeding Office, Lahan

There are two bull sheds, each having the capacity to keep 10 bulls. Both sheds are traditional with narrow central passage (Figure 18). Each bull pen has a standing area with manager and water trough and an open loafing area without a shed. Both standing and loafing areas are made up of concrete and hard.

Figure 18. Bull shed at LBO, Lahan

LBO, Lahan at present has 12 bulls, three of Hariana breed, 2 of pure HF and seven of Murrah breed. All bulls are in good condition and look healthy (Figure 19). There is no semen production for the last six months.

Figure 19. Bulls at LBO, Lahan

The semen processing laboratory has the necessary equipment to produce frozen semen doses. The straw filling and sealing machine of IMV is out of order (Figure 20). This is the main reason for not processing any semen doses at LBO Lahan for the last six months.

A liquid nitrogen plant is also being installed at BLO, Lahan (Figure 21). This LN plant has the capacity to produce about 30 litres of LN per hour. It will have the facility to pour LN directly into a container through a pipe. It will also have an option to fill up a storage tank of 1000 litre capacity directly from the

Figure 20. Semen processing laboratory at LBO, Lahan

Figure 21. LN plant being installed at LBO, Lahan

Figure 22. An LN road tanker at LBO, Lahan

plant. There is an additional 3000 litres storage tank installed a year back. This tank could also be connected to the LN plant and filled up. The technical specifications indicate that the plant would consume 30-70 units of power per hour. Taking the unit cost of power NRs. 10, the direct cost of running this plant other than salary would be NRs. 10-25 per litre of LN production

Besides, there is an idle LN road tanker of 3000-litre capacity, which could be made functional (Figure 22). LN could be filled in this road tanker from either of the storage tanks – 1000 litre capacity or 3000 capacity – and distributed to all LSS of the eastern region. LN can be poured into an LN container through a pipe.

LBO Lahan has one Senior Officer who is in charge of the Unit and four young qualified technical officers.

3.1.4 AI Delivery

As Nepal is migrating to a federal-state-local structure, the old institutional structure through which it had been providing semen doses and liquid nitrogen (LN) is also getting reorganized. Frozen semen doses are primarily produced at NLBO at Pokhara and a small number of doses are also produced at Livestock Breeding Office (LBO), Lahan, LN is procured from industrial sources as well as produced by a respective LN plant at NLBO, Pokhara, and LBO, Nepalganj, LN and semen doses are distributed by NLBO, Pokhara to Livestock Service Sections (LSS) of municipalities (as well as to District Hospital and Specialised Service Centres of State Provinces) of State Province 3 and 4, by LBO, Lahan to those of Province 1 and 2, and by LBO, Nepalgunj to those of Province 5 and 6. There are government, cooperative (community) and private AI centres/inseminators at the municipality level that provide AI services to farmers. Nepal is divided into seven provinces and local is divided into 77 districts, 753 local levels (including six metropolises, 11 sub-metropolises, and 276 municipalities). These 753 local units are known as the local level in Nepal. A total of 6,743 wards are formed under these 753 local levels. NLSIP will be functioning in 291 municipalities of 28 districts.

Figure 23. An oxygen plant producing LN, Pokhara

3.1.4.1 Distribution of Liquid nitrogen and Semen doses

NLBO and two LBOs procure their LN requirement from industrial sources such as oxygen manufacturing plants. LN is produced as a by-product in oxygen producing plants. At these plants, LN is filled in transport containers through a pipe directly from oxygen plants to LN containers (Figure 23). NLBO has an LN plant and is used whenever required. Though LBO, Nepalgunj has an LN plant, it is not operational right now. A new LN plant is being installed at LBO, Lahan. LN produced by the LN plants is also filled in LN transport containers.

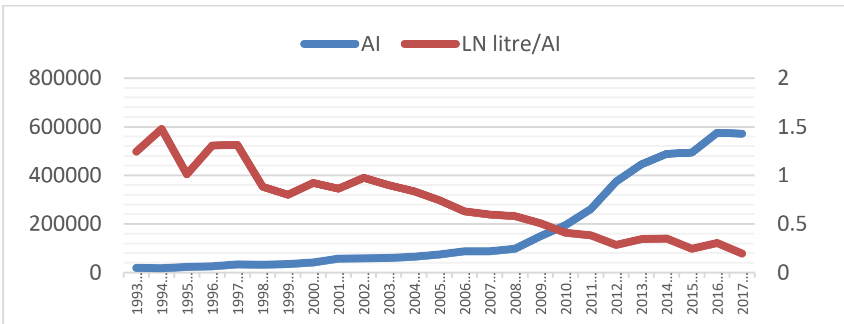
Such LN filled containers are then transported in a vehicle to Livestock Service Sections (LSS) of municipalities (Figure 24). For LBOs being away from Kathmandu their cost of procurement of LN is higher than that in Province 3 and 4 as they are being served from Pokhara. For example, LBO, Lahan every month transport some 44 empty 50 litres LN transport containers in a truck to Kathmandu about 400 km to collect LN from an oxygen plant. The LN filled containers are then transported back to Lahan and then distributed to LSS of municipalities. On an average, about 2200 litres (44 X 50=2200 litres) of LN is distributed every month to the municipalities of the Eastern sector other than that of Ilam district which procures their requirement of LN from the Oxygen plant in Kathmandu independently. For Ilam district, the cost of procurement of LN works out very high (See Box 1). Any saving in LN use through better technology may help considerably in reducing the overall cost of providing AI services. Besides, as the number of AI done increases the LN use per AI would also drop significantly (Figure 25).

Figure 24. Semen and liquid nitrogen storage at the LSS.

Inseminators come every three to four days at their respective LSS and get their 2-3 litres containers filled and buy semen doses. Inseminators are required to provide their insemination details to LSS. Each LSS store their monthly requirement of LN in LN storage containers and semen doses in semen storage containers (Figure 24). On their way to LSSs, LN is also delivered to AI technicians at specified places pouring LN from bigger containers to smaller containers.

Considerable losses of LN occurs at different delivery points: from oxygen plant or LN plant to transport containers, during transport of LN containers, while transferring LN from bigger to smaller containers at all delivery points, during storage, etc. Municipalities pay NRs. 30 per litre of LN to NLBO. LN is the biggest cost item of the AI delivery service. While distributing LN, semen doses are also distributed. NLBO, Pokhara, LBO, Lahan and LBO, Nepalgunj distributed some 2.30 lakh, 2.52 lakh, and 0.84 lakh doses respectively during 2017-18.

Figure 25. Relationsship between AIs and LN usage per AI



Box 1 LN procurement and distribution in Suryodaya municipality, Ilam

Suryodaya Muncipality is one of the four municipalities in Ilam district. Besides, there are 6 rural municipalities. These ten municipalities for supplying LN to their AI technicians arrange a truck together every month to get LN from Kathmandu which is about 600 km away from Ilam. In the truck they carry some 30 empty containers, get them filled at an Oxygen plant at Kathmandu and bring filled containers back to Ilam and distribute to 10 municipalities. For getting their 30 containers filled with LN, about 1200 litres, they have to incur transportation cost of about NRs. 110 per litre of LN, in all about NRs

(

1,34,000 (1200 litres x NRs. 110= 1,34,000) for transporting the containers for 1200 kms. This cost is borne by the municipalities. In addition to the transportation cost, municipalities have to pay NRs. 30 per litre of LN to BLO, Lahan, and Rs. 25 per semen dose. Municipalities charge NRs. 25 for supply of semen dose to the AI technicians and provide the necessary LN free to all AI technicians whether government or private. AI technicians charge NRs. 500-700 per AI for providing AI service to farmer's animals.

Suryodaya Municipality has two Livestock Service Sections: Fikkal and Barbote. Barbote is a sub-centre of Fikkal. These centres provide AI and veterinary health services in their areas. Under these two LSSs, there are 18 inseminators providing AI service to farmers. Three among them are government AI technicians and the others are private AI technicians. These AI technicians together carry out some 7000 AIs annually. LSS Fikkal has four LN distribution points where they keep LN storage and semen storage containers for distribution of LN and semen doses to 18 inseminators. These four centres consume in all about 300 litres of LN.

3.1.4.2 AI centres and inseminators

As per the official figures published in the annual report of NLBO, there were 963 AI centres and 1114 inseminators in 2017-18, the highest being in Province 5 and the lowest in Province 7. These AI centres during 2017-18 carried out in all 571,771 inseminations, 77 percent in cattle, 22 percent in buffaloes and about 1percent in goats (Table 16).

Some private AI technicians are engaged by cooperatives and some others work as freelance AI service providers. Many innovative ways private AI technicians optimize their income. During our field visit, we met two technicians who jointly own a bigger LN container for NL storage (See Box 2). Many of these private technicians also do veterinary treatment and some even own a veterinary medical shopThere are examples, sons received educatin and training in veterinary skills and continued their family business – a sustainable service in the community (See Box 3).

Box 2 Two private AI technicians in Kaski district

During our visit around Pokhara, we met two AI technicians - Ranabhat M. and Puran Chandra Gaire - one is associated with a primary milk cooperative named Naubise Milk Producer Cooperative Society, whereas the other is a freelance AI service provider.

Both of them use two litre container to carry semen doses for field use in a backpack and jointly have one 30 litre container for LN storage and 35 litre for semen storage. For the two litre container they spent NRs. 25,000 and for the two bigger containers NRs 62,000. The two litre container needs to be refilled every 3-4 days and the other two bigger containers every 15 days with 25-30 litres. The liquid nitrogen and AI accessories are supplied free of charge by the District Veterinary Hospital and Special Veterinary Service Centre (DVHSVSC) at a specified place, whereas semen doses are purchased by them at NRs 25 per dose irrespective of breed. DVHSVSC buys LN from NLBO at NRs. 30 per litre. In the opinion of the technician a loss of about 2-5 litres of LN happens at every transfer of LN from a 50 litres transport container to a 30 litres LN storage container and 2 litre while transferring from a 30 litre container to a 2 litre container. They buy about 200-250 semen doses at a time and store in their 35 litre semen storage container. Both of them do about 1600 AIs per year, 40 percent of them are of Jersey breed, another 20 of HF breed and the remaining 40 percent of Murrah breed. They operate in the radius of 15-20 kms. from their residence. They charge NRs. 100-600 to farmer for each AI service depending on the distance from their residence (NRs. 100 for 1-3 kms. to NRs 600 for 10-15 kms.) In the opinion of Mr. Dusema, the conception rate of animals he inseminates varies from 50-60%, whereas in Mr. Gaire’s opinion it varies from 40-45 percent.

There are 32 AI technicians in Kaski, 16 are government technicians, and 16 are private technicians. The cost of buying LN from nearby Oxygen Plant is about NRs. 60. In the opinion of the AI technicians in Kaski district most of the HF and Jersey crossbreds are artificially inseminated, whereas the coverage of AI in buffaloes is about 20 percent. Farmers pay about NRs. 1200-1500 for one natural service.

Box 3. A private paravet practice: family legacy - a case study in Morang

Mr. Chiranjivi Bhattarai is a registered private AI technician under Sundar Haraincha Municipality. He operates an AI centre, provides veterinary treatment and sells veterinary medicines. His father Mr. Som Bhattarai is also a Provate inseminator and paravet practitioner. This is an example of how family legacy perpetuates once an enterprise of veterinarty service provider is well established.

He keeps a 1.5-litre small container which he purchased in NRs. 30,000 three years back. Now it costs NRs. 18,000. The smaller container is also used as a semen storage container. He buys semen doses from the LSS every 15 days about 50-75 doses. He also keeps a 30-litre LN container and gets it filled at LSS of the Municipality every two months. The 1.5-litre LN container needs to be filled up from the bigger 30-litre container every three to four days. For LN he pays NRs. 30 per litre, while for semen dose NRs. 25. If he buys LN from an Oxygen Plant, he has to pay NRs. 150.

He carries out about 5 inseminations per day or about 150 per month, about 80 in HF, 60 in Jersey and 10-15 in Hariana cows. He charges NRs. 400-500 from farmer depending on the distance. After insemination, he issues a chit to farmers. By producing this chit at LSS the farmer gets NRs. 200 per insemination back. He operates in a radius of 10 km.



Farmers prefer HF crossbred cows over Jerseys. Sahiwal is also in demand. He also gets Sahiwal semen from an agent at the rate of NRs. 80 per dose. He also does the veterinary treatment. His turnover is NRs. 1.5 lakh and net earning about NRs. 40,000 to 50,000 per month. He treats 2-5 cases every day. The major problem is mastitis. He got training both in AI and veterinary treatment. His father Sombhatta Rai runs the veterinary medical shop. He himself was an AI technician. There are four AI technicians operating in the areas.

Table 16. Number of AI centres, inseminators and AI done during 2017-18

Province	AI Centres				Inseminators				Total AI			
	Gov.	CLBC	Pvt.	Total	Gov.	CLBC	Pvt.	Total	Cattle	Buffalo	Goats	Total
1	52	48	37	137	71	53	47	171	124042	9702	852	134596
2	40	33	25	98	43	33	29	105	68302	27610	1582	97494
3	88	96	37	220	110	98	43	251	147342	24466	1346	173154
4	63	69	26	159	80	71	31	182	45291	35284	143	80718
5	91	82	74	247	118	90	82	290	40994	25170	1053	67217
6	26	34	8	68	38	34	8	80	1183	420	324	1927
7	13	16	5	34	15	16	5	36	10990	5441	234	16665
Total	373	378	212	963	475	395	244	1114	438144	128093	5534	571771

Source: Annual report of NLBO-2017-18

The number of AI done is concentrated in 3-4 clusters of districts in the country; in the remaining part, it is thinly spread. The inseminations carried out during the 2017-18 show that the top 15 districts with respect to AI done in cattle constitutes 76 percent of the total cattle AIs in the country, the top 15 districts with respect to buffalo AIs make up to 72 percent, and the top 15 districts with respect to cattle and buffalo AIs together form 76 percent of the total cattle and buffalo AIs (Table 17). If one combines the top 15 districts with respect to cattle AIs, buffalo AIs and cattle and buffalo AIs together, there are 22 districts carrying out about 83 percent of the total cattle and buffalo AIs.

These 22 districts (i.e 29 percent of the total 75 districts) have 41 percent of cows in milk producing 47 percent of the total cow milk and another 43 percent of buffaloes in milk producing 47 percent of the total buffalo milk. The concentration of good animals in a few pockets and good coverage of animals under AI can greatly facilitate the establishment of a progeny testing programme and produce high-quality bulls for AI in the country, but the wider impact of such progeny testing programmes can only be realised when animals outside the project area of progeny testing programmes are also extensively covered under artificial insemination services. In other words, while efforts are made to establish efficient performance recording and genetic evaluation through progeny testing, equal efforts need to be made to expand AI network in the country to realize the full benefits of establishing genetic improvement programmes.

Table 17. Top districts with respect to AIs done during 2017-18

	Cattle	Buffalo	Cattle and buffalo
1	Chitwan	Nawalparasi	Chitwan
2	Morang	Rupandehi	Nawalparasi
3	Jhapa	Kaski	Morang
4	Kathmandu	Sarlahi	Rupandehi
5	Sunsari	Chitwan	Jhapa
6	Kavrepalanchok	Kavrepalanchok	Kavrepalanchok
7	Rupandehi	Siraha	Kathmandu
8	Nawalparasi	Lalitpur	Sunsari
9	Makwanpur	Kanchanpur	Kaski

10	Bara	Mahottari	Bara
11	Illam	Arghakhanchi	Makwanpur
12	Kaski	Kapilvastu	Illam
13	Parsa	Dhanusha	Sarlahi
14	Lalitpur	Sunsari	Lalitpur
15	Mahottari	Sindhuli	Parsa
% AI to Total AI	76%	72%	75%

3.1.4.4 Performance of AI services

The percentage of cows and buffaloes inseminated are estimated to be 24.13 and 4.57 respectively. These figures are derived by dividing the number of animals pregnant by the number of animals in milk. By this definition the estimated AI coverage could be on a little higher side as first, the breedable animals by definition should include animals in milk plus dry animals plus some percentage of heifers and not just in milk animals alone, and second, animals pregnant cannot be assumed to be animals inseminated as some animals after one insemination might have been made pregnant by natural service and there could also be some consistent repeat breeders. Another way to estimate the AI coverage could be to divide the number of animals inseminated by the number of breedable animals available for breeding. The number of animals inseminated could be derived by assuming an average number of AIs per animal and the number of breedable animals available for breeding by multiplying the assumed percentage of breedable animals available for breeding based on average inter-calving period. Assuming the average number of insemination of two per animal and the average percent of breedable animals available for breeding 70 percent, the coverage of AI in cows would work out to 14.5 percent and that in buffaloes 2.14 percent (Table 17). Whichever way one calculates the AI coverage, it is apparent that the overall coverage of AI in cattle and buffaloes is low. While in some better areas almost all cows and the majority of buffaloes are inseminated, in some other areas it is very small. A well-thought strategy, therefore, needs to be developed for increasing the AI coverage in many low-AI coverage areas.

Table 18. Estimated percentage of breedable cows and buffaloes inseminated during 2016-17

	No. of AIs 2016-17	No. of animals inseminated	Estimated no. of breedable animals[1]	Estimated no. of breedable animals available for breeding[2]	Percentage of breedable animals inseminated
Cow	4,44,149	2,22,075	21,92,897	15,35,028	14.46 %
Buffaloes	1,21,460	60,730	40,60,587	28,42,411	2.14%
Overall	5,65,609	2,82,805	62,53,484	43,77,439	6.46%

1. Breedable animals are estimated by multiplying the animals in milk in 2016-17 by the ratio of breedable animals to in milk animals derived from the census figures of 2011. The estimated ration is 2.13 for cows and 2.69 for buffaloes.
2. The percentage of breedable animal available for breeding is assumed to 70.

Achieving conception rates consistently higher than 55 percent in cows and more than 48 percent in buffaloes for the last several years is very impressive. Not becoming complacent on the achievements, one needs to put in place an appropriate information system to follow up each AI on the individual animal basis and also a system to verify the results of AI.

3.1.4.5 Past trend of AI and AI coverage

The past trend of AIs done indicates that in the past one decade the number of AIs carried out in cattle increased by an average of 42,954 per year and that in buffaloes by 12,229. The percentage of breedable cattle inseminated increased from 6.81 in 2011-12 to 14.06 in 2017-18 and that in buffaloes from 1.14 percent to 2.19 percent (Table 19).

Table 19. Past trend of AI and percentage of breedable cattle and buffaloes inseminated

Year	AIs in cattle	AIs in buffaloes	Total AI	% breedable cattle inseminated	% breedable buffaloes inseminated
2007-8	70,503	16,146	86,649		
2008-9	79,305	18,960	98,265		
2009-10	1,18,492	30,769	1,49,261		
2010-11	1,48,467	40,689	1,89,156		
2011-12	2.03,288	56,878	2,60,166	6.81	1.14
2012-13	2,84,505	89,824	3,74,329	9.28	1.74
2013-14	3,41,334	1,03,920	4,45,254	11.14	2.05
2014-15	3,83,301	1,04,609	4,87,910	12.49	2.07
2015-16	3,91,709	97,650	4,89,359	12.77	1.92
2016-17	4,44,149	1,21,460	5,65,609	14.43	2.14
2017-18	4,38,144	1,28,093	5,66,237	14.06	2.19

Source: AI figures from the Annual report of NLBO-2017-18.

3.1.5 Milk Producers Cooperative Societies

There are 1750 Milk Producers Cooperative Societies (MPCS) in Nepal, which play an important role in milk production, collection, and marketing. MPCSs collect milk from their members and non-members on the basis of quality, sell the collected milk to dairy processors - Dairy Development Corporation (DDC), private dairies, etc., receive payment from dairy processors, and make payment to milk producers. They also buy and sell various concentrates and also engage AI technicians for providing AI services to their members (See Box 4). Many societies have installed milk chillers for supplying chilled milk, some others have created facilities to process their milk into milk and milk products like pasteurized milk, ghee, dahi, panner, etc. and sell these products in local markets (See Box 5). Many MPCSs at the district level have formed a district milk producers' cooperative union (DMPCU) which could also have facilities for processing of various products. MPCSs and DMPCUs, in turn, have formed a central level organisation called Central Dairy Cooperative Association Limited Nepal (CDCAN). CDCAN works towards enhancing the income of dairy producers.

During our field visit, we had an opportunity to visit some well-managed dairy cooperative societies. In our opinion, some of these primary dairy cooperative societies can be entrusted to undertake activities like test inseminations, milk recording, milk component analysis, and data collection.

Box 5. Naubise Milk Producer Cooperative, Lekhnath, Kaski

Naubise Milk Producer Cooperative Society

Naubise Milk Producer Cooperative Society was established in 2006 with the collection of 16 litres of milk. At present, it collects 4000 litres, 2000 litres in the morning and another 2000 litres in the evening. About 80 percent of this milk is cow milk and the other 20 percent buffalo milk. It has 128 shareholders and other 300 are pourer members without share.

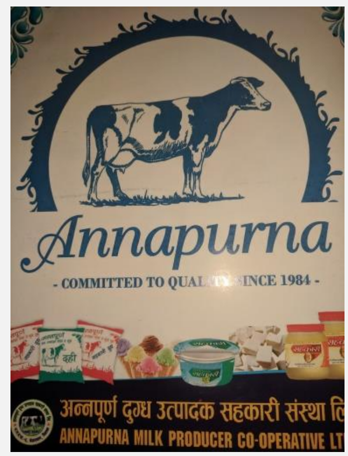
The village has about 900 cows and 200 buffaloes. Some 70 percent of cows are Jersey high-grade crossbred cows and 30 percent are Holstein high-grade crossbreds. Average production per day of both HF and Jersey is 8-10 litres. The highest production in HF crossbred cow reported is 30 litres and that in Jersey crossbred 20 litres. All crossbred cows in the village are artificially inseminated. The conception rate is assumed to be around 60% in crossbred cows. There are eight inseminators providing service in the village. The best inseminator is doing about 1600 AI per year. Average could be around 1000 per year.

The farmers get NRs. 50-51 per litre for cow's milk and NRs. 60-65 for buffalo's milk. The collected milk is sold to Safal Milk Processing Plant. The Milk Processing Plant pays as follows: NRs. 5.94 for each 1% fat and NRs. 3.07 per 1% SNF per litre. In addition, NRs. 1.5 is paid for every 1% of total solid. The 68 percent of the additional money received is passed on to farmers, while 32% is kept by the society.

The society is governed by nine elected members. The members are elected every three years. The society has employed a manager, milk testing technician, and cattle feed sales assistance. Cattle feed is sold in 25 kg., 40 kgs. and 50 kgs. begs. Prices vary from NRs. 38 to 42 per kg. The Society is affiliated to Saptgandalai District Cooperative Milk Producers' Union. The Union has 42 Village level societies as their members. The Union has small processing plant processing about 35,000 litres of milk daily.

Box 6. Annapurna Milk Producers' Cooperative Ltd. Gitanagar, Chitwan

Annapurna Milk Producer Cooperative Ltd. was established in 1984. At present, it has 365 shareholders and another 135 non-member pourers. Its daily collection varies from 3200 to 5500 litres depending on the season. It has six mobile liquid milk collection routes. About 60-70 percent of the collected milk is processed into milk and milk products like curd, ghee, fresh cream, paneer, sweets, etc.; the rest is sold to processors (mostly to DDC) as chilled milk. They have three retail outlets in Bharatpur through which it sells its milk and milk products. They pay price for milk to producers as decided by DDC. Currently, the producers are paid NRs. 5.50 per each fat percentage and NRs. 3.05 for each SNF percentage per litre. The producers also get a bonus every year. Last year the producers were given a price difference of 10 percent on milk purchased value and a bonus of NRs. 3 per litre.



The society also produces about 5 tons of cattle feed daily and sells it to their members in 30 kgs. and 50 kgs. begs. The price of cattle feed to its members is NRs. 28 and to non-members NRs. 40 per kg. The cattle feed contains 18 percent CP. It has also established a farm for a demonstration of improved animal husbandry practices to its members. The farm at present has 85 cows, 40 of which are in milk, producing in all 350 litres with an average of 8.75 litres per day. All cows are crossbred cows. They work closely with the local AI technicians for AI services to their members.

3.2 Goats

3.2.1 Breeding Practices

Observations and interactive discussions with farmers and stakeholders reveals that majority of the farmers have knowledge about consequences of random mating and inbreeding. However, they do not bring their knowledge into practice for two reasons: mostly owner knows, but keepers do not know about breeding management; and even if they know they just ignore it at the time of breeding event (a usual practice of ignoring applying the knowledge, saying "*aa... chali halchhani...".* meaning let it be like this time....and the trend continues adopting random mating spoiling the next generation of goat offspring. This is an overall status, though in some communities there are Bucks maintained for breeding services on payment basis.

We found that farmers are maintaining less number of breeding bucks; in the ratio of one buck for up to 300 breedable does in a village; which technically is not acceptable and productivity might have been reduced because one male for too many females . This situation again promotes random mating as other bucks are not castrated. No selection system of does for desirable traits based on genetic merits is existent.

Figure 26. Privately managed bucks for crossbreeding in Bardia.

At the Program level some strategic issues are adopted by DLS, however, field level actions are not evident. For example, DLS strategies for goat development are:

a) Development/improvement of Sinhal and Chyangra breeds of goat for high hills and mountain regions by proper Selection methods.

b) Development/improvement of Terai, Khari, Sinhal and Chyangra breeds of goat by proper Selection & Outbreeding methods.

c) For Mid hills, selection of Khari and crossbreeding of Boer, Barberi & Jamunapari males to Khari females.

The AFSP and KUBK projects are promoting crossbreeding programs with Boer goats. 100% Boer flocks are maintained at ARS Bandipur and RARS Khajura – both are government stations . The production and productivity data are yet to be analysed and compared with other native, exotic or their crosses. Preliminary results show promising results (Fig 27).

Figure 27. A poster for on informatoon on Boer goat (ARS Bandipur)

3.2.2 Some community initiatives in cluster for Selection for genetic improvement

Operations of selection program in the community level seems feasible and practical. Some initiatives were taken in the past by ISFP, ASFP and Heifer International Nepal. Data recording were paper based. Heifer used a computer program developed in Access. Since data collection and analysis is not carried out on a regular basis, there is basically phenotypic selection only occuring, though farmer apply some cut of value of litter weight at weaning and five month live weight for selecting their animals as seed animals or for meat purpose as usual (see text Box 7). These examples suggest more intensive efforts are needed to run a scientific goat selection program.

Box 7. Goat breeding stock production: a case study from Boughagumba, Palpa

Once a week, farmers from Boudhagumba gather in the premise of Milansar Social Entrepreneur Women's (SEW) Cooperative to sell their goats. The Cooperative which is a part of Heifer's "Community Initiative for Genetic Improvement of Goats " (CIGIG) sub-project has already sold 374 seeds goats used for breeding and 187 meat goats worth NPR 5,026,000 (approx. USD 50,261) in total since it started operating the goat marketing business in January 2015.

With the help of CIGIG sub-project which started in September 2013, Boudhagumba is transforming into a resource center for production of seed animals of genetic merit. Goat farmers are increasing their goat's productivity by practicing selective breeding and improved animal health and management. In addition, the Milansar SEW Cooperative is helping farmers to market their products, improving their access to the market.

Sumitra Rana, one of the 530 memebers of the cooperative has received training on filling "Household record form" to record productivity of selected nanny goats and their offspring. Each nanny goat is tagged for identification and their performance parameters such as kidding and twinning rates are recorded while their offspring's weight gain record is recorded to determine their genetic merits, based on which they will be used for either breeding or meat purpose.

3.2.3 Semen import, production and AI status in goats

Improved Seed for Farmers (ISFP; also call KUBK) funded for importation of Boer semen from the USA. NLBO is storing and coordinating semen distribution along with AI program. Semen is supplied to project districts. A total of 4500 doses were imported (Table 20).

Table 20. Import of Boer semen doses from USA

	2015		USA	Boer	3000	KUBK
	2017		USA	Boer	1500	KUBK
Total					4500	

In the year 2074/75 a total of 5534 inseminations were performed in goats. With an estimated conception rate of 35 % it can assumed that some 1700 new crossbred of Boer were added in the country through AI program in goat.

NLBO Pokhara is now equipped with facilities for collection and processing of goat semen. Due to compromised conception rate, the demand for got semen is very limited. NLBO reports that the semen

Box 8. Frozen semen production of Khari goat: a success case

The study was conducted to evaluate the seminal attributes, effectiveness of cooling process and post- thawed semen quality of a Nepalese indigenous Khari buck. Thirty-two ejaculates, 16 from each buck were studied for seminal attributes of fresh semen: volume, color, mass activity, motility, viability, sperm concentration, and morphology. The pooled mean values for each seminal attributes were: volume 0.7±0.3 ml; color 3.1±0.3 (milky white); mass activity 3.8±0.4 (rapid wave motion with formation of eddies at the end of waves to very rapid wave motion with distinct eddies formation); sperm motility 80.9±5.6%; sperm viability 94.6±2.0%; sperm concentration 2597.0± 406.8x106/ml; abnormal acrosome, mid-piece and tail 10.7±1.8% and abnormal head 5±1.7%. For freezing semen, further 6 ejaculates from each buck were studied with Tris based egg yolk citrate extender. The pooled mean values of motility and viability of post diluted semen for 90 and 120 minutes each for cooling and glycerol equilibration were 73.8±4.8%, 88.1±2.6% and 69.2±6.0%, 85.0±1.7%, respectively. The pooled mean values of post thaw motility and viability with advancement of preservation time were: 0hour 49.0±4.6%, 81.2±1.9%; 2nd day 41±2.2%, 79±1%; 5th day 41±2.2%, 78.6±0.9% and 10th day 41±2.2%, 78.6±0.9%. We concluded from the above study that the seminal attributes and results of post-thaw semen quality were satisfactory and in accordance with other work in foreign countries, which indicated the feasibility of cryopreserving buck semen. For more validation, research with large number of

In Nepal production of frozen semen of Khari breed of goat has also been commenced as a research trial. Details of applied part are yet to be determined. Experimental findings reveal promisising scenario (see text Box 8). Production of Boer semen is routinely practiced at NLBO.

From our field observations and state level workshop recommendations we would work out genetic improvement of goats at the community level. PPRS system in community clusters will be designed in collaboration with, DLS or NARC farms. The PPR system should include at least 2000 does for each category of breed comprising the herds of government farms, outreach sites and commercial farms prevalent in the localities.

- Selection program for Ajmeri crossbred goats with upgrading plan using bucks of Ajmeri breed
- Selection program for Khari (native) goats using bucks of Native Khari breed
- Selection program for Boer crossbred goats with upgrading plan using bucks of Boer breed

Figure 28. Some of tbe Valuableexotic goat breeds - Boer (left) and Sirohi crosses (right)

The technical details for operation of these breed improvement program are described in Chapter 4 of the report (Strategy and action plan).

Chapter 4
Framework for genetic improvement

4.1 Vision

The vision of Nepal's livestock genetic improvement is to build infrastructure and put processes in place to provide the maximum number of farmers high-quality genetics that enhances the production and productivity of livestock in the sustainable manner in the country's diverse production systems and environmental conditions, while simultaneously attending the self-sufficiency in meeting both consumers' demand for livestock products and producers' demand for high-quality genetics and protecting the existing huge livestock genetic diversity. In all its endeavours the country will ensure maximum participation of women and address the issues related to environmental and social safety measures.

4.2 Framework for genetic improvement

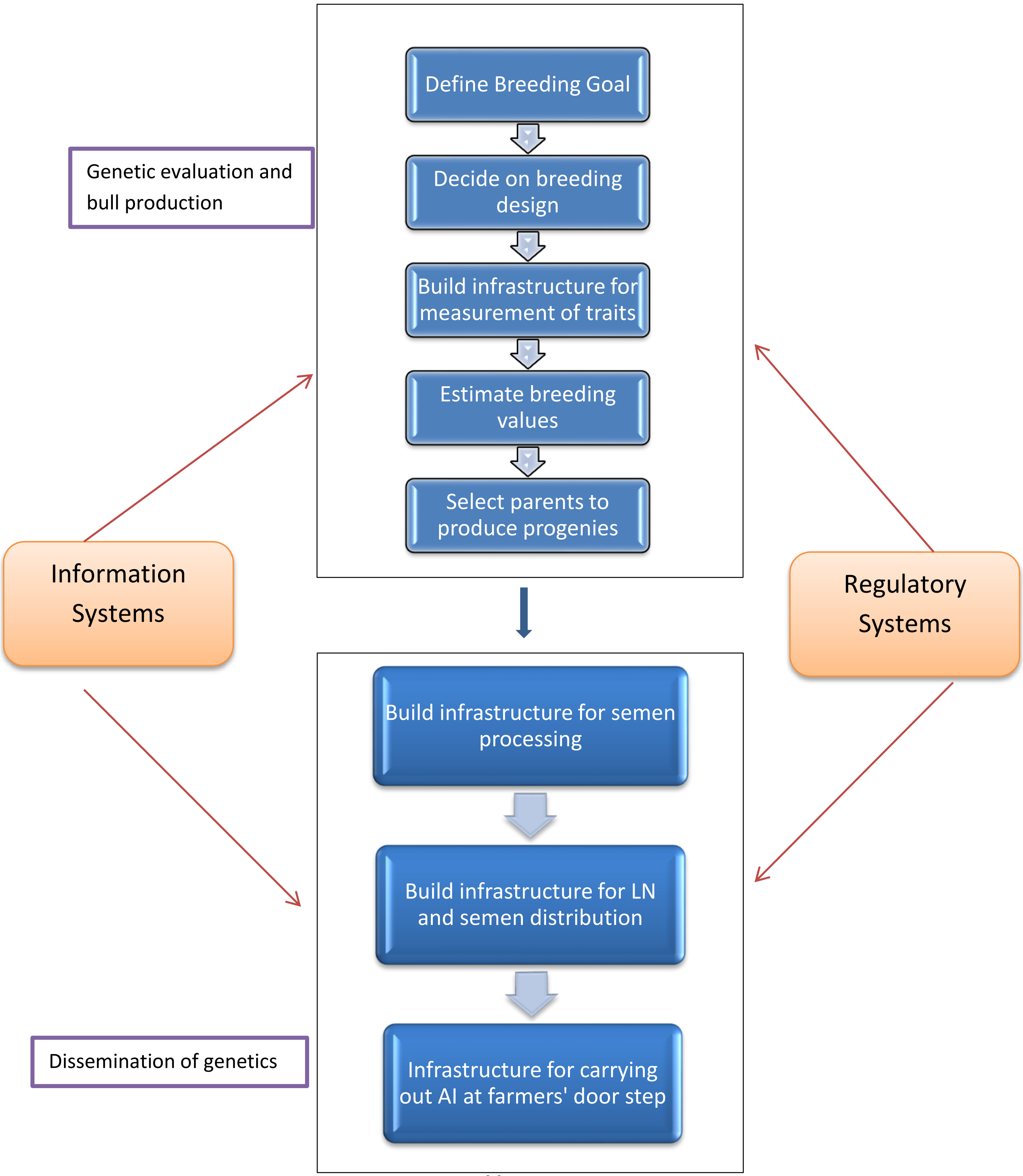
The genetic improvement involves the following steps:

1. Defining a breeding goal.
2. Deciding on breeding design.
3. Building an infrastructure for measurement of traits and recording pedigree on an individual animal basis.
4. Estimating breeding values.
5. Selecting parents of the next generation and mating them to produce progenies.
6. Building infrastructure for disseminating genetics of selected individuals: semen processing, LN and semen dose distribution, AI delivery.
7. Establishing an information system to record data of all events of both genetic evaluation and dissemination and generate information for all stakeholders.
8. Establishing a regulatory mechanism for breeding activities including genetic improvement, semen production, and AI delivery.

A few key points to be considered in developing the above-mentioned steps are given below. The process to be followed is depicted in Figure 29.

Defining a breeding goal:
Defining a breeding goal involves identifying the traits that all stakeholders including farmers would like to improve and assigning a goal value to each identified trait. The key question to be answered is why farmers keep animals in a given production system and what purpose it serves to them. It would also be necessary to consult other stakeholders in the dairy value chain such as consumers, retailers, distributors, processors, and breeding service providers and find out from them what traits they would like to include in the breeding goal. The process of consultation should lead to arriving at a consensus on the traits to be included in the breeding goal. The genetic improvement programme could be initiated with the most important breeding goal and later with the information derived from the early implementation of the genetic improvement programme, the goal could be further refined.

Figure 29. Framework for genetic improvement



Deciding on breeding design: In any population, there will be farmers who have better animals than others. Strategically, it would be very advantageous to organize such farmers and initiate performance and pedigree recording and put in place systems of genetic evaluation and production of replacements with them. Such a group of farmers is referred to as "breeding nucleus". They produce replacements for themselves and also for other farmers outside the nucleus referred to as commercial farmers. Commercial farmers improve their herd without having performance recording and genetic evaluation systems. The nucleus needs to be open to get superior performing animals from commercial farmers as well as from other populations (other countries) with higher genetic means, but their performance needs to be tested in a given production environment as there could be genotype-environment interaction. Progeny testing is the most effective way to achieve genetic progress in any population as the four key factors of genetic improvement – selection intensity, accuracy of selection, genetic variation, and generation interval - can effectively be employed over all four paths of genetic progress namely sire-sire, dam-sire, sire-dam, and dam-dam. As in many developing countries, age at first calving is delayed because of poor feeding and management practices, it is often not practical to use only progeny tested sires for AI to produce herd replacement as by the time progeny test results of bulls put to test are available the bulls no more exist. A more practical way is to use some selected young males produced using semen of progeny tested sires and top recorded dams for AI to produce replacement heifers. In this situation, the use of genomic information becomes very important in increasing the accuracy of selection of young males for AI. One should also ensure that the bulls put under test programme are the sons of very best sires and dams. Progeny testing is very expensive, but if applied with all scientific principles in mind and sustained for a long period of time, the benefits are multi folds over costs. The efficiency of a progeny testing could be increased with putting as many bulls as possible under test, increasing the number of daughters per bull, putting very best bulls at a very young age for test mating, and constantly refining the method of estimating breeding values.

Building an infrastructure for measurement of traits and recording pedigree: The first important step in recording any trait of animal is to identify the animal by applying an ear tag with a unique number. With a recording of AI date, bull number, the result of pregnancy diagnosis, calving date, and sex of calf born many reproductive traits such as conception rate, number of inseminations per conception, age at first calving, service period, and inter-calving period could be calculated. Recording of a bull number at the time of AI and registering the newborn at the time of reporting calving make it possible to have pedigree of all registered calves. Likewise with a recording of morning and evening milk yields and analysis of milk sample for milk component once a month for the entire lactation of the animal, many production traits such as test-day milk yield, fat yield, protein yield, and 305-day milk, fat and protein yields could be derived. Recording of certain functional traits helps in selecting animals for good health and longevity. The cost of recording of data for measuring different traits on an individual animal basis, in fact, works out to be the major cost item in implementing any genetic improvement programme.

Estimating breeding values: The performance records and pedigree data collected are then used for estimating breeding values of bulls and recorded females using a mixed model BLUP (Best Linear Unbiased Prediction) procedures. A random regression test-day model is the current choice for estimating breeding values wherein all test day records are used.

Selection of parents to produce the next generation of progenies: Based on the estimated breeding values, top bulls and top bull mothers are selected. The selected bull mothers are then inseminated with the semen of top proven bulls to produce the next generation of young bulls. Based on the breeding values of young bulls, the required bulls for semen production are selected.

Dissemination of genetics: Dissemination of genetics involves: (i) Production and processing of semen doses; (ii) Distribution of liquid nitrogen (LN) and semen doses, and (iii) Delivery of AI services.

Production and processing of semen doses: Required infrastructure needs to be built to produce and process semen doses. One has to ensure that only the very best bulls produced through genetic improvement programmes are used for semen production and that the semen production and processing technologies are refined to produce an ever-increasing number of doses per bull with high sperm motility and no disease-causing organisms.

Distribution of liquid nitrogen (LN) and semen doses: Producing LN through an exclusive LN producing plant is always costlier than procuring LN from industrial sources where LN is produced as a by-product. As LN is a major cost of AI delivery service, creating facilities for bulk LN sourcing, storage and delivery help in reducing the overall cost of LN supply against the practice of procuring, storing and delivering through small transport containers. Supply of LN should be either through a portable LN tanker of 500 to 2000 litre capacity with the gravitational flow or through an LN delivery pump and not by pouring LN from one container to another. The other important aspect is adhering to the schedule of delivering of LN and semen doses. AI centres also need to have a container for LN and FSD storage, preferably of 35-litre capacity, and a small portable LN container, preferably 2-3 litre capacity, to carry the FSDs to the place where AI is to be carried out.

AI delivery: AI service providers should ensure that they collect semen doses from accredited semen stations and of bulls of high genetic merit. They should also ensure that the AI technicians engaged by them follow the Standard Operating Procedures (SOP) for carrying out AI. For the larger impact of the genetic improvement programme, it is necessary to expand the AI network. Equally important is to improve conception rates and reduce the overall requirement of semen doss per conception.

Establishing an information system: Developing a good information system is a prerequisite for implementing a genetic improvement programme. The information system should have provision to collect data on an individual animal basis for all events such as identification and registration, AI, PD, calving, milk recording, milk components, type traits, etc. as they happen and generate and make available information to all stakeholders including farmers. There should also be a system for recording of all events of semen production, processing, quality control, sales, and inventory.

Regulatory systems: There has to be an institutional mechanism to register and certify genetic improvement programmes, semen production stations, and AI technicians to ensure quality AI services to farmers.

Chapter 5
Development of strategies and programs for genetic improvement

This chapter develops strategies and programs for genetic improvement first for cattle and buffaloes and later for goats.

5.1 Strategies and programs for genetic improvement of cattle and buffaloes

5.1.1 Introduction

This chapter examines the past trend of population of cattle and buffaloes and their milk yields and makes projections first under a scenario of business as usual for next 15 years with regard to population, milk productivity, total milk production, the percentage of breedable cattle and buffaloes covered under artificial inseminations, the requirement of semen doses, and the bulls required for replacement. It then makes projections with the proposed NLSIP interventions and arrives at the target for next 15 years including those for the year ending NLSIP project for AI coverage, the requirement of semen doses, the number of semen doses to be imported, the number of semen doses to be produced locally, and the number of bulls of different breeds required for replacement. Based on the projected requirement of bulls for replacement, it proposes the specific programs for genetic evaluation and production of bulls and the infrastructure that needs to be created for performance and pedigree recording and genetic evaluation as well as for dissemination of genetics. Finally, an action plan is drawn for each proposed program including standard operating procedures to be followed.

5.1.2 Setting national goals for genetic improvement

Two scenarios one with business as usual and the second with NLSIP interventions have been examined and broad NLSIP targets for AI coverage, semen production, and bulls for replacement have been arrived at.

5.1.2.1 Business as usual

The past compounded annual growth rate (CAGR) percentages calculated based on the past ten years' data of total cattle, total buffaloes, cows in milk, buffaloes in milk, cow milk production and buffalo milk production indicate that the buffalo population has grown much faster than that of cattle, whereas the rate of growth of cow milk production has been much higher than that of buffaloes (Table 21). The projections of the total cattle and buffaloes, cattle and buffaloes in milk, and milk production of cows and buffaloes made for the base year 2017-18, the year-end of NLSIP - 2023-24, and the 15th year end i.e by the end of 2031-32 based on the respective CAGR are given in Table 20. From the projections of cows in milk and total cow milk production, the average productivities of cows for different years have been calculated. Likewise, based on the projected buffaloes in milk and total buffalo milk production, the average productivities of buffaloes have been derived. The average productivity figures of cows and buffaloes derived for the year-end of NLSIP i.e 2023-24 indicate that under the scenario of business as usual, the productivity of cows will grow by about 27 percent on the base figure of 2017-18, whereas the productivity of buffaloes will decline by about 2 percent. Similarly, by 2031-32, the productivity of cows will increase by about 83 percent and that of buffaloes will decline by 4.7 percent.

Table 21. Projections of population, milk production, and milk productivity under business as usual

	Unit	CAGR* 2007-8 & 2016-17	Base Year 2017-18	For NLSIP year end - 2023-24	For 15th year end - 2031-32
Total cattle population	Million	0.422	7.379	7.563	7.860
Total buffalo population	Million	1.718	5.267	5.834	6.800
Population of cows in milk	MMT	1.256	1.042	1.124	1.257
Population of buffaloes in milk	MMT	2.989	1.555	1.855	2.418
Milk production cows	MMT	5.411	0.701	0.962	1.546
Milk Production buffaloes	MMT	2.656	1.279	1.497	1.895
Average productivity - cows	Kg./day		673	856	1230
Average productivity -buffaloes	Kg./day		823	807	784

CAGR – Compounded annual growth rate

In the last one decade, the number of inseminations carried out in the country in cattle increased by an average of 42,954 per year and that in buffaloes by 12,229. Taking these figures, the number of inseminations carried out under the scenario of business as usual by the year-end of NLSIP would be about 700 thousand in cattle and 200 thousand in buffaloes, and the percentage of breedable cattle and buffaloes inseminated would be about 21 and 3 respectively. In the next 15 years, with the same assumptions, the number of inseminations carried out in cattle would increase to 1000 thousand and in buffaloes to 300 thousand. Likewise, the percentage of breedable cattle and buffaloes inseminated would increase to about 21 and 3.0 respectively (Table 21). In the last decade, roughly 15 percent of the total doses used are imported. Assuming that about 15 percent of the requirement of semen doses would be imported every year, the total number of doses to be produced locally and the number of bulls required for replacement could be worked out (See Table 21). Under the scenario of business as usual, the number of cattle and buffalo bulls required for replacement during the NLSIP period would be 29 and 26 respectively.

5.1.2.2 With NLSIP interventions

As not many changes in population dynamic are expected, the total population of cattle and buffaloes are predicted to grow at the normal rates as assumed under the scenario of business as usual. However, small changes in the population of cows in milk and buffaloes in milk are foreseen after the initial project period of NLSIP. It is assumed that the population of cows in milk will grow by about 1.3 percent during the project period and by 1.5 percent thereafter. The population of buffaloes in milk is assumed to increase by 3 percent during the project period and by 3.5 percent thereafter. The past growth in cow milk production is quite high and it may not be possible to raise it further. An average annual growth rate of

Table 22 **Projections of the number of semen doses to be produced and the number of bulls required for replacement under business as usual**

	Unit	Base Year 2017-18	For NLSIP period 2018-19 to 23-24	For NLSIP year end - 2023-24	For 15th year end - 2031-32
Inseminations carried out:					
Cattle	In ‘000	438	3,531	696	1,082
Buffaloes	In ‘000	128	1,012	195	308
Breedable animals inseminated:					
Cattle	%	14.1	-	20.7	28.8
Buffaloes	%	2.19	-	2.9	3.4
Semen doses imported:					
Cattle	In ‘000	-	583	115	-
Buffaloes	In ‘000	-	167	32	-
Semen doses produced locally:					
Cattle	In ‘000	561	3301	651	1012
Buffaloes	In ‘000	98	946	182	288
Bulls under semen collection:					
Cattle	Number	18	-	23	36
Buffaloes	Number	13	-	20	32
Bulls required for replacement:					
Cattle	Number	-	29	6	9
Buffaloes	Number	-	26	5	8

Assumptions: On an average 15% of the total doses required are imported; average semen doses produced per bull per year: 30,000 for pure HF, pure Jersey and crossbreds, 10,000 for zebu, and 9,000 for buffalo breeds; bulls replaced every year: 25%.

6.5 percent is assumed for cow milk production. However, the potential of buffaloes has not been exploited fully. A slightly higher growth rate in buffalo milk production is assumed. An annual growth rate in total buffalo milk production is assumed to be 4 percent during the project period and 4.5 percent thereafter. Based on the projected figures of animals in milk and total milk production, the average production per animal in milk per day for cows as well as for buffaloes have been calculated. The average milk production per cow in milk by the year-end of NLSIP works out to 908 kg. and that by the end of the 15th year to 1400 kg. (Table 23). Similarly, the average milk yield of buffaloes in milk for the NLSIP year-end works out to 872 kg. and for the 15th year to 951 kg. The average productivity of cows in milk will increase by 35 percent by the year-end of NLSIP over the base figure of 2017-18 and by 108 percent by the end of the 15th year. Likewise, the productivity of buffaloes in milk will increase by about 6 percent over the base figure of 2017-18 by the year-end of NLSIP and by about 16 percent by the end of the 15th year.

Table 23 **Projections of population, milk production, and milk productivity under NLSIP interventions**

	Unit	CAGR* 2007-8 & 2016-17	Base Year 2017-18	For NLSIP year end - 2023-24	For 15th Year end - 2031-32
Total cattle population	Million	0.422	7.379	7.563	7.860
Total buffalo population	Million	1.718	5.267	5.834	6.800
Population of cows in milk	Million	1.256	1.042	1.126	1.288
Population of buffaloes in milk	Million	2.989	1.555	1.856	2.530
Milk production cows	MMT	5.411	0.701	1.023	1.804
Milk Production buffaloes	MMT	2.656	1.279	1.618	2.405
Average productivity – cows	Kg./day		673	908	1400
Average productivity -buffaloes	Kg./day		823	872	951

Assumptions: The growth rate of total cattle and buffaloes assumed unchanged; Population of cows in milk is assumed to grow by 1.3% annually during the NLSIP period and by 1.5% thereafter; population of buffaloes in milk is to grow by 3.0% during the NLSIP period and by 3.5 thereafter; cow milk production is assumed to grow by an average of 6.5% and that of buffalo by 4% during the project period and by 4.5 thereafter.

It is targeted to raise the coverage of breedable cattle under AI from the current level of 14.1 percent to 30 percent by the year-end of NLSIP and to 50 percent by the end of 15 years, and in the case of buffaloes from the current level of 2.2 percent to 15 percent by the year-end of NLSIP and to 40 percent in 15 years. To achieve the targeted coverage of breedable animals under AI, the number of inseminations to be done in cattle will go up from the current level of 438 thousand to 1010 thousand and in buffaloes from 128 thousand to 837 thousand by the year-end of NLSIP and to 1925 thousand in case of cattle and to 3614 thousand in case of buffaloes by the end of 15 years (Table 24). It is assumed that the current level of import of about 15 percent of the total doses will continue during the NLSIP period and reduce to 10 percent thereafter as more high-quality local bulls would be available from the genetic improvement programmes. Consequently, the semen doses production will have to be raised from the current level of 561 thousand to 945 thousand in the case of cattle and from 98 thousand to 783 thousand in the case of buffaloes by the year-end of NLSIP. In the next 15 years, the cattle semen dose production will have to be raised to 1906 thousand and that of buffaloes to 3578. By the year-end of NLSIP, there will be 34 cattle bulls and 52 buffalo bulls under semen collection. During the NLSIP period, 34 cattle bulls and 46 buffalo bulls would be required to be obtained from the genetic improvement programmes for bull replacement.

Table 24 Projections of the number of semen doses to be produced and the number of bulls required for replacement under NLSIP interventions

	Unit	Base Year 2017-18	For NLSIP period 2018-19 to 23-24	For NLSIP year end - 2023-24	For 15th year end - 2031-32
Inseminations carried out:					
Cattle	In '000	438	3929	1010	1925
Buffaloes	In '000	128		837	3614
Breedable animals inseminated:					
Cattle	%	14.1	-	30	50
Buffaloes	%	2.19	-	15	40
Semen doses imported:					
Cattle	In '000	-	698	167	212
Buffaloes	In '000	-	491	138	398
Semen doses produced locally:					
Cattle	In '000	561	3955	945	1906
Buffaloes	In '000	98	2783	783	3578
Bulls under semen collection:					
Cattle	Number	18	-	34	69
Buffaloes	Number	13	-	52	239
Bulls required for replacement:					
Cattle	Number	-	34	9	17
Buffaloes	Number	-	46	13	60

Assumptions: On an average 15% of the total doses required are imported during NLSIP period and 10% thereafter; average semen doses produced per bull per year: 30,000 for pure HF, pure Jersey and crossbreds, 10,000 for zebu, and 15,000 for buffalo breeds; bulls replaced every year: 25%.

5.1.3 Action plan for genetic improvement

Having estimated the requirement of bulls, the next step is to produce the required bulls and disseminate their genetics to produce the required herd replacements. Section 5.1.3.1 describes the plan for the production of genetics and section 5.1.3.2 the plan for the dissemination of genetics.

5.1.3.1 Genetic evaluation and production of bulls

As described in Chapter 4, genetic evaluation and production of bulls involve five steps: (i) Defining breeding goal; (ii) Deciding on breeding design; (iii) Building infrastructure for performance and pedigree recording; (iv) Estimating breeding values, and (v) Selecting parents to produce the next generation of progenies.

5.1.3.1.1 Defining breeding goal

The stakeholders during our consultation with them suggested that milk yield, milk component yields (fat and protein), fertility and function traits should be included in the breeding goal for the genetic improvement of the mainstream breeds (HF crossbreds, Jersey crossbreds and Murrah crossbreds). The general consensus was also there on estimating breeding values for individual trait and selecting parents based on production traits without compromising on fertility and functional traits to start with and later developing an index combining production, fertility, and function traits and selecting parents based on the index value.

5.1.3.1.2 Deciding on breeding design

Based on the discussions with stakeholders, three mainstream breeds namely HF crossbred, Jersey crossbred, and Murrah crossbred are selected for developing a systematic genetic improvement programme for each of them.

With our assessment of the AI infrastructure and the availability of quality animals, we arrived at the following three clusters of districts for implementing the three proposed genetic improvement programmes (Table 25). These three clusters would produce herd replacements for themselves and also for the farmers outside these clusters. The locations of three clusters are also depicted in Figure 30.

Table 25 Cluster of districts for three proposed genetic improvement programmes

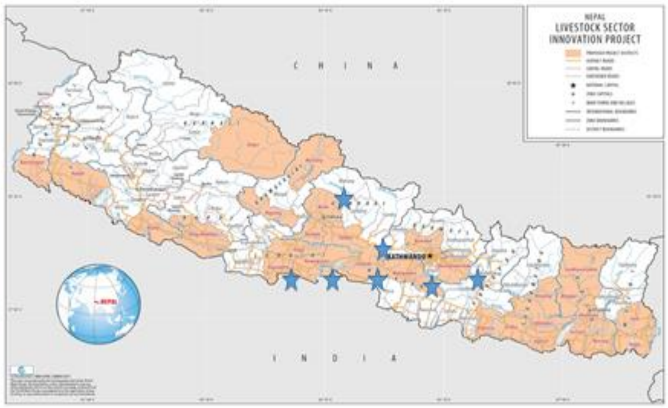
Cluster	Primary breed	Secondary breed
Cluster I: Kaski, Tanahun, Chitwan, Rupandahi, Makwanpur, Nawalparasi, and Kavre	HF crossbred	Jersey crossbred and Murrah crossbred
Cluster II: Ilam, Jhapa, Morang, Sunsari, and Dhankuta	Jersey crossbred	HF crossbred and Murrah crossbred
Cluster III: Kapilvastu, Navalparsi, Rupandehi, Saptari, Sirahi, and Dhanusa	Murrah crossbred	HF crossbred and Jersey crossbred

We think implementing a progeny testing programme for each breed will be the most effective way to achieve genetic progress in the population as the four key factors of genetic improvement – selection intensity, accuracy of selection, genetic variation, and generation interval - can effectively be employed over all four paths of genetic progress namely sire-sire, dam-sire, sire-dam, and dam-dam under a progeny testing programme. We also recognize that it will not be possible to implement a classical progeny testing programme, as the age at first calving is high because of poor feeding and management practices and hence, by the time progeny test results of bulls put to test are available the bulls either would not exist or would be too old to give semen. A practical way, we think, is to use top selected young males produced using semen of progeny tested sires and top recorded dams for AI to produce replacement heifers. In this situation, we also recognize the importance of genomic information to enhance the accuracy of selection of young bulls to be used for semen production. Besides, it is equally important to ensure that the bulls put under test programme are the sons of the very best sires and dams. In this context, it would be prudent to use imported semen of very best progeny tested sires to produce young male calves to be put under the test programme along with young bulls produced using semen of local progeny tested bulls and top recorded dams. In the first two years, it will also be necessary to import semen of young bulls to put them under test programme, as there will be no young bulls available in the first two years for putting them under test programme. Though progeny testing is very expensive, if applied with the necessary scientific vigour and sustained for a long period of time, the benefits are multi folds over costs. We, therefore, propose a modified progeny testing programme as proposed here and use selected young sires produced using top progeny tested sires and top recorded dams for semen production. The breeding design proposed for progeny testing is depicted in Figure 31 and briefly described below.

Figure 30. Cluster of districts for three genetic improvement programmes

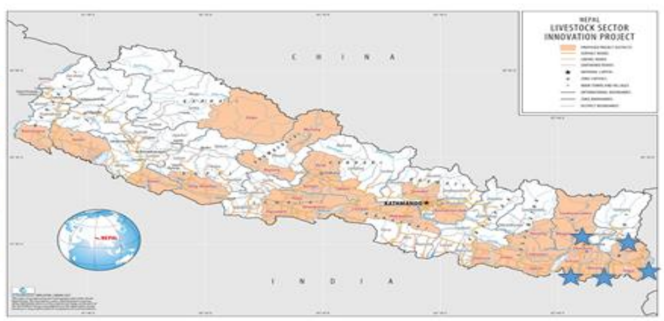
Cluster I : Proposed HF Crossbred Project districts

	HF Crossbred Project Area (including Jersey Crossbreds)
1	Chitwan
2	Kavre
3	Makwanpur
4	Kaski
5	Nawalparasi
6	Tanahun
7	Rupendahi



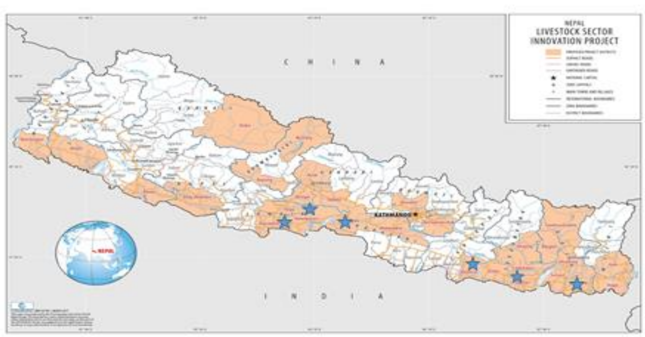
Cluster II: Proposed Jersey Crossbred Project districts

	Jersey Crossbred Project Area (Including HF crossbred)
1	Illam
2	Jhapa
3	Morang
4	Sunsari
5	Dhankuta



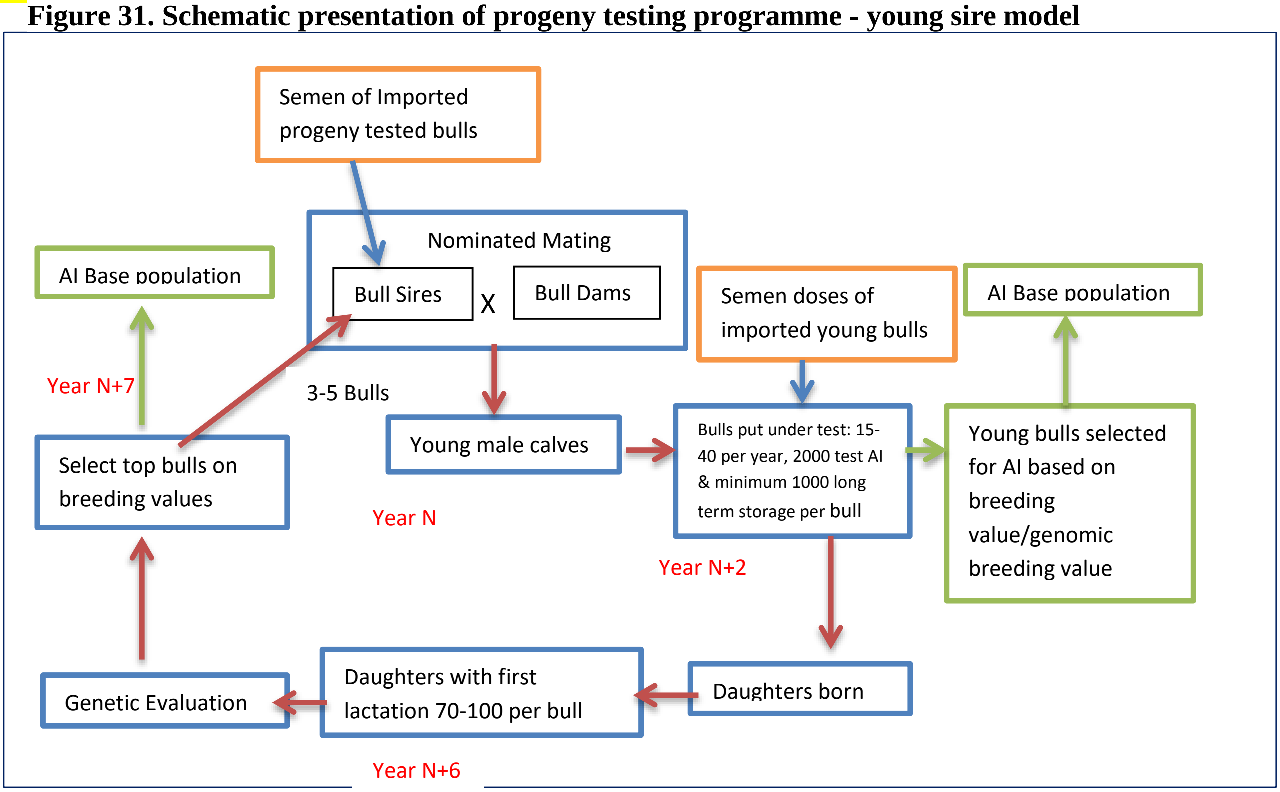
Cluster III: Proposed Murrah crossbred buffalo project districts

	Murrah Buffalo Area
1	Navalparsi
2	Kapilvastu
3	Rupeandehi
4	Saptari
5	Sirlahi
6	Dhanusa



About 15-20 bulls will be put to test in the first year and the number will be raised to 30-40 in the fifth year. These bulls should have been produced using very best sires and dams. If an adequate number of young bulls are not available locally, semen doses of young bulls will be imported. While selecting young bulls for import of semen doses, it would be ensured that they had been produced using very best sires and dams. On average about 100-150 semen doses of very best progeny tested bulls will also be imported of each breed every year to produce young bulls to be put under test in subsequent batches of test bulls. About 2000 doses of each bull put under test will be distributed in as many herds/villages to ensure that at least 70 to 100 complete first lactation records of daughters per bull in as many herds/villages as possible are made available for estimating breeding values of bulls with very high reliability. In addition, some 1000-1500 doses per bull will be stored till progeny test results of bulls put to test are available. The stored doses of top progeny tested bulls will later be used for nominated mating to produce young bulls to be put under test. The required infrastructure to carry out test inseminations and recording all production, reproduction and functional traits will be established. An appropriate software application will be developed to capture data of all events like identification and registration, AI, pregnancy diagnosis, calving, female calf registration, female calf follow-up for growth, milk recording, body type recording, etc. The very best 10 percent of progeny tested bulls and the very best 5-10 percent of recorded cows will be used for producing the next generation of young bulls. About 50 percent of young bulls after their test inseminations will be selected based on their breeding value/genomic breeding value based on pedigree/genotype information for semen production. The semen doses of these bulls will be used in the field for production of herd replacement. The process of putting bull under test, estimating breeding values based on daughter performance, selecting top bulls based on breeding values to produce the next generation of young bulls, putting selected young bulls under test, and selecting some young bulls after their test mating for semen production and AI will continue year after year. It is assumed that with employing this process, in the long term on an average genetic progress of 1 to 1.5 percent per year will occur.

Figure 31. Schematic presentation of progeny testing programme - young sire model



5.1.3.1.3 Building infrastructure for performance and pedigree recording

The number of municipalities that can carry out some 40,000 inseminations per year each in HF crossbreds, Jersey crossbreds and Murrah crossbreds in the first year and some 80,000 in each breed in fifth year will be selected for establishing the infrastructure for performance and pedigree recording. Within each selected municipality all villages/wards will be selected for the programme and within the selected villages all dairy herds/farmers will be persuaded to participate in the programme. Once the farmers are selected, their all animals whether they are HF crossbreds or Jersey crossbreds or Murrah crossbreds will be included under the performance and pedigree recording. The necessary facilities then will be set for performance and pedigree recording taking the Livestock Service Section (LSS) of Muncipality as the coordinating centre for all recording activities within its jurisdiction. The necessary facilities and working arrangement to be established for recording all traits within each selected municipality are briefly described below (a standard operating procedure for measurement of all traits is provided in Annex II).

The Livestock Service Section of each municipality will have the required LN and semen storage containers to store their monthly requirement of LN and semen doses. The municipality will have a dialogue with all inseminators whether they are engaged by government or cooperative or working as freelance AI technician. The municipality will sign an MoU with each inseminator to carry out certain activities under the project. The AI technician's responsibility will be to collect test doses from the LSS and carry out AI only with the test doses. The other main responsibility of the AI technician will be to collect the required data for AI, PD and calving events and submit to LSS (data to be collected at the time of AI, PD and calving are given at Annex I). Initially, the data will be collected through formats which would be submitted to the LSS where the collected data will be entered using a web-application on the desktop. Later, once an application is developed on the smartphone, the data collection would be through smartphones. NLSIP will make the required provision to provide an incentive to AI technicians for recording all events of AI, PD and calving. With the collection of data on AI, PD, and calving the value of certain reproductive traits such as conception rate, number of inseminations per conception, service period, inter-calving period, etc. will be calculated.

Each municipality through existing cooperatives in its area will engage the required number of milk recorders on contract basis to record once a month morning and evening milk yields of all animals in milk of participating farmers. One milk recorder will be engaged for one or two villages depending on the number of farmers' animals to be recorded. The number of animals a milk recorder can record depends on the number of animals farmers have and distances between two farmers. It would not be possible for a milk recorder to record animals of not more than three to four farmers in a day. Each recorder will be provided with a set of measuring jars or an electronic weighing machine to measure the quantity of milk produced and a few sample bottles to collect milk sample at each morning milking of all animals milk recorded. He will also be provided with a couple of sample boxes or begs to send the milk samples bottles to the LSS of municipality, where a milk component analyzer will be installed to carry out milk component analysis for fat, and protein. Milk yields of individual animal initially will be recorded in formats by the milk recorder and the filled in formats will be sent to the LSS where data will be entered (the data to be collected at each milking time are given at Annex I). The data of milk component analysis will automatically be transmitted from the milk analyzer to the computer. The data collected will be used to calculate all production traits such as test day milk yield, fat yield, fat %, protein yield, protein %, 305 day milk yield, fat yield, protein yield, etc. Milk recorders will be paid for each milk recording.

A few type recorders will be engaged who will do typing of daughters born during their first lactation between 60 to 120 days postpartum once in their life span. Each type recorder will be provided with measuring equipment like measuring tape, wooden ruler, stature measuring device, angle measuring device to measure and/or score internationally accepted 16 type traits: Stature, Heart girth, Body length, Body depth, Angularity; Rump angle, Rump width, Rear legs set, Rear legs rear view, Foot angle, Fore udder attachment, Rear udder height, Central ligament, Udder depth, Front teat placement, Teat length, Rear teat placement, Rear udder width, Teat thickness, and Body condition score. All typers will be trained in measuring and scoring type traits. It is assumed that one typer will be able to type about 1000 to 1200 animals in a year.

5.*1.3.1.4 Estimating breeding values*

Once sufficient daughter records are available, breeding values of bulls and recorded females will be estimated using an appropriate Random Regression Test day BLUP model. Standard breeding value estimation software such as WOMBAT, DMU, BLUP90, etc. will be used for estimating breeding values. Breeding values will be published every six months.

5.1.3.1.5 Selection of parents to produce the next generation of young males

Based on the breeding values, bulls and bull mothers will be selected to produce the next generation of young male calves. Some selected male calves will be put under test programmes and a few selected among them will be used for semen production and AI.

A year wise key activities to be undertaken for genetic evaluation and production of bulls are summarized in Table 26.

Table 26 A schedule of activities for genetic evaluation and bull production

Period	Sr.N	Activity
Year 1	(1)	Set up a project team at NLBO of three persons one responsible for performance recording and genetic evaluation, second responsible for semen production, LN and test doses distribution, nominated mating and procurement of male calves, and third responsible for all activities related to data handling.
	(2)	Identify one person at each Decentralized-Level Support Unit of NLSIP to coordinate all breeding activities within its area of operation.
	(3)	Identify the required number of municipalities to carry out 40,000 inseminations each in HF, Jersey and Murrah crossbreds.
	(4)	Identify inseminators within each selected municipality, identify area of operation of each selected inseminator, and get an MoU sign with each inseminator
	(5)	Engage the required milk recorders in collaboration with local dairy cooperative societies within each selected municipality, identify area of operation of each selected milk recorder, and get an MoU sign with each milk recorder.
	(6)	Equip LSS of the selected municipalities with the required LN and semen storage containers and install a milk component analyzer at each LSS.
	(7)	Identify one person at each LSS who will do milk sample analysis and also data entry initially.
	(8)	Identify one person at each LSS to supervise all project activities
	(9)	Purchase the required ear tags, tag applicators, milk weighing scales (or jars or electronic weighing machines) and supply to all identified LSSs.

	(10)	Print the required formats and supply to all identified LSSs
	(11)	Organize regional training programmes for the identified inseminators and milk recorders
	(12)	Import 3000 semen doses each of 10-15 young bulls of HF, Jersey and Murrah; identify 5-10 local young bull each of high grade HF, Jersey and Murrah crossbreds, and have a first batch of 15-20 young bulls for test inseminations.
	(13)	Import 100-150 high quality semen doses of progeny tested bulls each of HF, Jersey and Murrah to be used for producing young male calves to be put under test mating in subsequent batches.
	(14)	Prepare month wise semen doses distribution schedule – which bull's semen to be used at each municipality – to ensure that each bull put under test programme is used in as many municipalities as possible and across all months; about 2000 doses of each bull is to be used in a year's time.
	(15)	Store minimum 1000 doses of each bull put under test till their progeny test results are available; the stored doses top proven bulls to be used for nominated mating for producing the next generation of young males.
	(16)	Carry out 2000 test inseminations per bull; AI technicians to record all events of AI, PD and calving.
	(17)	Put all animals of participating farmers under monthly milk recording beginning first recording after calving; milk recorders to records all yields and take milk samples for milk component analysis and arrange to send milk samples to their respective LSS, may be through inseminators who visit LSS every 3-4 days for refilling their small containers and getting semen doses.
	(18)	Provide feed-back to participating farmers.
	(19)	Put a supervisory system in place.
Year 2 and Year 3	(1)	Repeat activities numbered 12-18 of Year 1
	(2)	Follow up daughters born for growth and health
	(3)	Select top recorded females based on available information and suitably correcting records; carry out nominated mating with the imported progeny tested semen doses to produce young male calves for test mating and also to be used for semen production for AI.
	(4)	Follow up the males born using imported progeny tested semen and procure them after following SOP for confirmed parentage and negative for diseases.
Year 4	(1)	Repeat activities numbered 12-18 of Year 1
	(2)	Repeat activities numbered 2-4 of Year 2 and Year 3
	(3)	Record milk yields and milk components of daughters
	(4)	Cary out typing of daughters in their first lactation between 60 to 120 days after calving
Year 5 onwards	(1)	Repeat activities numbered 12-18 of Year 1
	(2)	Repeat activities numbered 2-4 of Year 2 and Year 3
	(3)	Repeat activities numbered 3 and 4 of Year 4
	(4)	Undertake breeding value estimation of bulls put under test and recorded females

	(5)	Decide on the mix of top local progeny tested bulls and imported progeny tested bulls for nominated matting to produce young males calves.
	(6)	Review project activities and take the necessary corrective action

5.1.3.2 Dissemination of genetics

Dissemination of genetics involves: (i) Production and processing of semen doses; (ii) Distribution of liquid nitrogen (LN) and semen doses, and (iii) Delivery of AI services.

5.1.3.2.1 Semen production and processing

As described in Section 5.2.1, to cover some 40 percent of breedable cattle by the year-end of NLSIP, the frozen semen doses production would need to be raised to some 1000 thousand doses and to cover 50 percent by the 15th year-end to some 1900 doses. To produce the required doses by the year-end of NLSIP, some 35 bulls will be under semen collection and by the 15th year-end some 70 bulls. Likewise, in the case of buffaloes, to cover some 15 percent of breedable buffaloes by the year-end of NLSIP, the frozen semen doses production would need to be raised to 800 thousand and to cover 40 percent of breedable buffaloes by the 15th year-end to some 3600 thousand. And to produce the required doses of buffalo semen, some 50 buffalo bulls will be under collection by the year-end of NLSIP and some 240 bulls by the 15th year-end.

At present, the semen station at NLBO has the capacity to maintain 37 bulls. This means to maintain in all about 85 bulls by the year-end of NLSIP, additional bull housing facility to maintain an additional 48 bulls would need to be created. It is proposed that two modern bull sheds each to house 24 bulls 12 on either side like one shown in Figure 32 with adequate space for delivery of feed and fodder by a tractor between two rows of individual bullpens, good ventilation with a high roof, and each bullpen with one part having a hard surface and another part having a soft loafing area with a roof may be built.

Figure 32. A modern bull shed

The existing semen collection arena is quite spacious. To improve bull management and achieve optimal semen production and at the same time minimize the risk of injuries to semen collectors, it is proposed that the existing semen collection arena be renovated with either having soft floor totally or part having a soft surface and the other hard and enclosed by railing having escape gates in either case like one shown in Figure 34.

Figure 33. Modern semen collection arenas

The semen processing laboratory is quite spacious with all the required equipment adequate enough to process more than five million doses. To enhance its operational efficiency, the following equipment may be provided:

1. Generator (25 KVA) for power Backup
2. Olympus Phase Contrast Binocular Electric Microscope with Camera and Led Monitor set.
3. Semen straw cold handling cabinet preferable from IMV France, Minitube Germany or FHK Japan
4. Two Box Air Showers
5. Five ACs for the different laboratory rooms.

There is a buck shed near cattle shed. From the biosecurity perspective, it is advisable to shift the buck shed a little away from the existing cattle sheds. After constructing the proposed two new sheds and providing adequate space for future expansion, the entire area of the semen processing laboratory, semen collection arena, and bull sheds need to be cordoned off making it totally bio-secured with restricted (or no) entry. Strict biosecurity measures are required to be implemented to prevent the introduction of any disease-causing agents in the semen station. Signboards highlighting bio-secured area need to be placed at the main entrance and also at other prominent places. Proper tyre wash should be maintained at the main entrance for disinfection of incoming vehicles. A shoe cover and hand washing facility for the visitors to wash their hands before entering the semen station need to be created. Isolation shed a little away from the main shed need to be built for separating sick animals.

There is no quarantine facility for incoming bull calves from the field. It is proposed that a quarantine shed is built at a distance away from the main shed for keeping about 15-20 calves. The operations of the quarantine station should be independent of the main station. Separate workers should be employed for the quarantine station.

5.1.3.2.2 Distribution of liquid nitrogen (LN) and semen doses

As pointed out in Chapter 3, the biggest cost of providing AI service is the cost of procuring/ production and delivery of liquid nitrogen to various LSSs of municipalities. There is a liquid nitrogen plant at NLBO, Pokhara and two new LN Plants are being installed one at LBO, Lahan and another at LBO, Gaughat. LN is also procured from local oxygen plants. Production of LN is always costlier than procuring from industrial sources as LN is often produced as a byproduct in producing something else. In oxygen manufacturing plants, LN is produced as a byproduct in producing oxygen. Thus, the cost of LN production works out much cheaper. We, therefore, propose that other than three LN plants, there is no need to install any new LN plant and LN should be sourced from the available industrial sources in a decentralized way. To operate the whole system of liquid nitrogen and semen distribution system efficiently, we propose that eleven liquid nitrogen storage tanks of 1000-3000 litres capacity are installed at strategic locations. Annual contracts could be entered with local LN suppliers for bulk supply of LN into LN storage tanks. Procuring LN from local industrial sources always works out cheaper. Once LN is received, it could then be delivered to all LSSs around each LN storage tank on a specified schedule preferably through vehicle mounted LN road tanker of 500-2000 litre capacity or through LN transport containers (See Figure 34). When LN is transported through a road tanker and delivered through hosepipe directly into containers at the delivery points, the loss is very much minimized against the practice of delivering LN from bigger containers to smaller containers. The storage tank could be located at VHLSSC or LSS of municipality or semen bank. Initially, they could be owned and operated by LNBO/LBO and later could be transferred to local level institutions. The proposed locations of LN storage tanks are given in Table 27.

Figure 34. An efficient LN distribution system

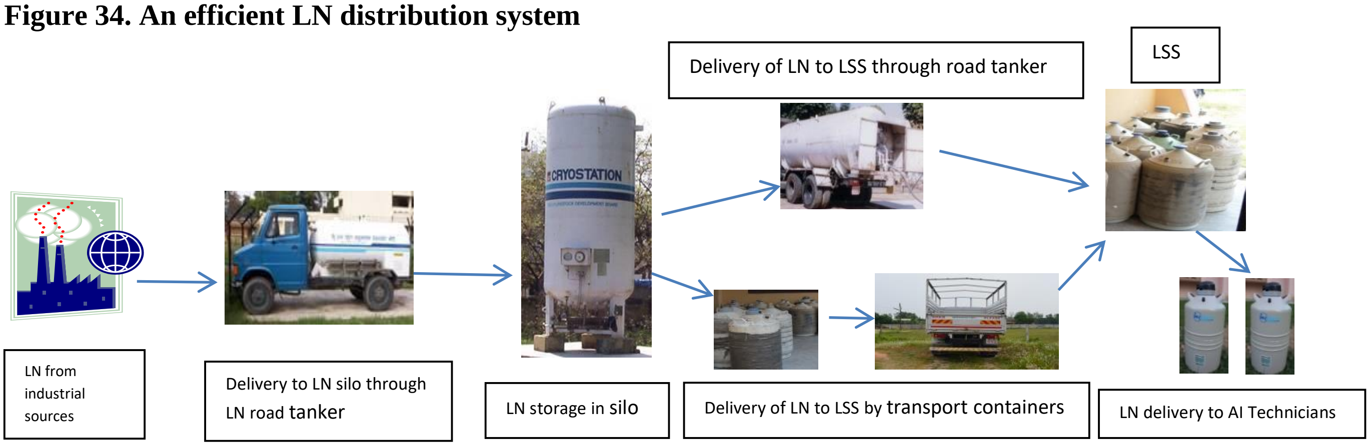


Table 27. Proposed locations of LN storage tanks

	District	Possible location		District	Possible location
1	Jhapa	Damak or Birtamod	6	Chitwan	Bharatpur
2	Morang	Biratnagar or RARS Tarahara (NARC)	7	Kathmandu	Khumaltar or Tripureshwor
3	Siraha	Lahan	8	Rupandehi	Butwal
4	Sarlahi	Hariwon	9	Dang	Ghorahi or Tulsipur
5	Makawanpur	Hetauda	10	Banke	Nepalgunj or Kohalpur

5.1.3.2.3 AI delivery

At present 475 government, 395 cooperative and 244 private AI technicians in all 1114 have been providing AI service to farmers. During 2017-18, they together carried out 571771 inseminations 77 percent in cattle, 22 percent in buffaloes and about 1 percent in goats. For enhancing the genetic progress, it is targeted to increase the percentage of breedable cattle inseminated from the current level of 14.1 to 30 by year-end of NLSIP i.e 2023-24 and to 50 in the next 15 years and that of breedable buffaloes from 2.19 percent to 15 percent by 2023-24 and to 40 percent by 2031-32. To achieve these targets, the number of inseminations to be done needs to be raised from the current level of 438 thousand to some 1000 thousand in the case of cattle and from 128 thousand to 800 thousand in the case of buffaloes by 2023-24. The current annual average number of inseminations carried out by an inseminator is 513; however, it is as high as 928 in Province 3 and as low as 24 in Province 6, though the contribution of Province 6 to total AI is less than 0.3 percent. Assuming that in the future all inseminators together would carry out about 600 inseminations per year, to do some 1800 thousand inseminations the country would need about 3000 inseminators by 2023-24. This means about 1900 new inseminators would need to be inducted.

There is huge potential to expand AI coverage in the country. Though the average percentage of animals inseminated is 14.1, there is vast variation among districts. For example, in Kathmandu about 92 percent of breedable cattle are inseminated, whereas there are 12-15 districts where there is hardly any AI in breedable cattle. In the case of buffaloes, there is enormous scope. The coverage of buffaloes under AI is very low and hardly anything in some 20 districts. A strategic AI expansion plan needs to be made identifying potential districts where efforts need to be focused and how progressively other districts could be selected.

The districts could be classified based on the number of breedable animals and the coverage of AI. The districts that have a high number of breedable animals and medium AI coverage could be selected first for AI expansion efforts and then progressively other districts could be selected that have high breedable population but low AI coverage. A priority list of districts for progressively increasing AI coverage could be made and implementation strategies could be developed. Based on the available data and with some assumptions an approach is developed to progressively select districts for AI expansion. In Figure 35 districts are listed classifying them on the number of breedable cattle and AI coverage. The districts in the top right hand corner are the top priority district for AI expansion as they have a large number of breedable cattle and a medium level of AI coverage. The arrow shows the path way for selection of other districts. Likewise see Figure 36 for the expansion of AI in buffaloes.

Figure 35. Potential districts for AI expansion in cattle

	> 50	LALITPUR KASKI KATHMANDU	RUPANDEHI			
Breedable Cattle % covered under AI	20-50	BHAKTAPUR	PARSA	MAKWANPUR NAWALPARASI CHITWAN	KAVRE BARA	JHAPA
	15-16	TANAHU				MORANG SUNSARI
	11-15	PARBAT LAMJUNG GULMI ARGHAKHANCHI	SIRAHA	UDAYAPUR RAUTAHAT DHANUSHA	KANCHANPUR MAHOTTARI	ILLAM
	6-10	RAMECHAP SYANGJA BAGLUNG	DANG BARDIYA DHANKUTA SINDHULI	BANKE NUWAKOT	KAILALI KAPILBASTU SARLAHI	
	0-5	MANANG DOLPA KALIKOT HUMLA MUGU JAJARKOT ACHHAM OKHALDHUNGA DARCHULA BAJURA RUKUM SOLUKHUMBU ROLPA DAILEKH JUMLA MUSTANG TAPLEJUNG MYAGDI GORKHA PYUTHAN RASUWA PALPA SINDHUPALCHOK	KHOTANG BHOJPUR DADELDHURA TERHATHUM SANKHUWASHAVA SURKHET DOLAKHA PANCHTHAR	BAITADI SALYAN DOTI DHADING	BAJHANG	SAPTARI
		0-20	21-40	41-60	61-80	81-100
		Districts having different range of breedable cattle (%)				

Districts highlighted with blue colour are the districted selected for HF PT project and those highlighted with red colour are selected for the Jersey PT project. The districts encircled are the potential districts for AI expansion. The direction of arrow indicate the path way to select other potential districts.

Figure 36. Potential districts for AI expansion in buffaloes

	> 5					RUPANDEHI
	4-5	BHAKTAPUR PARBAT	LALITPUR	CHITWAN SARLAHI	NAWALPARA SI	
	3-4		SINDHULI	KANCHANPUR		KAVRE KASKI
	2-3	JUMLA DHANKUTA	PARSA RAMECHAP KATHMANDU	RAUTAHAT	ARGHAKHAN CHI	SIRAHA
Breedab le buff. % covered under AI	**1-2**		ILLAM GULMI	SYANGJA JHAPA TANAHU	MAKWANPUR BAGLUNG BARDIYA MORANG	KAILALI BARA BANKE SUNSARI MAHOTTARI KAPILBASTU DHANUSHA
	< 1	MUSTANG HUMLA DOLPA MUGU DARCHULA BAJURA KALIKOT ACHHAM JAJARKOT BAJHANG TAPLEJUNG RASUWA MANANG	BAITADI BHOJPUR KHOTANG OKHALDHUNGA DADELDHURA SOLUKHUMBU RUKUM DOTI TERHATHUM MYAGDI ROLPA SANKHUWASHAV SURKHET PYUTHAN SINDHUPALCHOK LAMJUNG DOLAKHA PANCHTHAR	SALYAN DAILEKH GORKHA PALPA	DHADING DANG NUWAKOT UDAYAPUR	SAPTARI
		0-20	**21-40**	**41-60**	**61-80**	**81-100**
		Districts having different range of breedable cattle (%)				

The districts highlighted with blue colour are those selected for Murrah PT project. The districts encircled are potential districts for AI expansion. The arrow shows the path way for selection of districts for AI expansion.

The future engagement of technicians can be done through the existing cooperatives and producers organisations. NLBO, LBO and VHLSSC can organise new AI technicians training programmes and issue a license for AI after proper skill test. Refresher training programmes could be organised at VHLSSC. Financial support should be provided from State and Federal governments for the entire AI program in all the municipalities, keeping cooperatives and producers' organisations in the semen and liquid nitrogen distribution network. AI services should be incentivized by local governments. Incentives could be paid to AI technicians directly based on the records submitted through LSS. A system for regular monitoring and assessment of inseminators' technical skills should be developed and implemented. NLBO should prepare guidelines for implementing the required AI monitoring system.

5.1.3 Conservation and sustainable use of native breeds of cattle, buffaloes

As described in Chapter 2, there are seven indigenous breeds of cattle namely Lulu, Achhami, Phahadi, Khaila, Terai and yaks and three buffalo breeds viz. Lime, Parkote, and Gaddi. The indigenous cattle breeds provide needed organic manure and draught power for agriculture production, nutrition through milk, and supplementary income through bones and hides. The buffalo breeds are important for milk and meat besides their contribution to manure, hide and bones. The indigenous breeds are resistant to diseases, have the ability to survive in harsh environmental conditions and on low nutrition diet, and are important to provide sustainable livelihood to a large number of farmers in marginal areas. The population of Lulu cattle found in Mustang and Manang districts has been declining. Likewise, Lime buffaloes are also declining fast. The population of Yak found in the northern mountainous region has been declining drastically and feared that soon no Yak will be available to produce Chuari the most important draught-purpose animal for agriculture, transport, and tourism in the Himalayan ranges. These breeds may not be important for meeting the consumers' demand of milk but they are very important for agricultural production, meeting household needs of animal protein, and providing a livelihood to a large section of people in hills and mountainous regions of the country. It is important therefore that sincere efforts are made for their conservation and development.

There is a need to develop practical in situ breed conservation and development programmes based on two-tier or three-tier breeding structure initially through natural service and gradually changing over to AI involving research institutions, local NGOs and local governments. The challenge will be to define right breeding goals – traits to be included in breeding goals and their weights - and develop the right infrastructure for measurement of traits included in breeding goal as some of the traits of important in local breeds like resistance to diseases, surviving in harsh climate, ability to perform under low nutrition diet are difficult to measures in the field. The government must make budgetary provision to support such local breed development efforts and sustain them for a long period of time.

5.2 Goat Genetic Improvement Program

5.2.1 Introduction

There is wide variation in productivity parameters (body weight gain, kidding rate, kidding interval, twinning rate and kid mortality) of the goat flocks irrespective of the breed of different locations in Nepal. This situation warrants introduction of animal identification and performance recording system. This unique identification and recording allow adoption of selection as a tool of technical intervention for genetic improvement. AFSP and ISFP projects in the past imported Boer goats, placed in government/NARC farms, and selected farmer communities with a purpose of establishing breeder and multiplication herds. Their performance in general is claimed and reported to be promising. The projects aimed at establishing a robust PPRS. However, performance recording of individual animals and selection did not occur. Selection of better performing animals based on genetic selection does not exist. All the progenies born from imported bucks and their crosses raised are sold as breeding stocks. The upgrading of native breeds with Boer goat seemed successful but the inference so far is based on phenotypic performance under farmer conditions. Data recording, storage and analysis at community levels were missed out in these projects. Establishment of Performance recording in itself is an innovation and requires intensive efforts from the side of farmers, farmer institutions and animal scientists.

Assessment of breeds and breeding practices in the country revealed that the current breeding events are mostly at random in all the breed categories of goats. Boer breed is showing promising results in most of the locations. An evaluation study under farmer conditions concluded that the growth performance of Boer crossbreed is better than other crossbreeds[4] and can easily adapt from Terai to mid-hills of Nepal.

Artificial insemination of goat has recently been introduced in Nepal. Successful pregnancies from AI are less than 35% (NLBO 2018); it is also a challenge of improving the pregnancy rate for better adaptation of AI in goat[5]. Private resource centers for Boer goat seem to have monopoly in marketing as they are demanding an inflated and unaffordable price for Boer breeding bucks. This is one of the reasons small and marginal farmers have not adopted Boer goat to the extent they should have done seeing its profitability. Under status quo situations, there is less chance for smallholder farmers to adopt Boer goat production without strategic intervention. In our field visit, most of the goat farmers expressed their eagerness to raise Boer goat; huge gap is there in demand and supply, therefore, the price is impractically high. This necessitates production of breeding stock of Boer goats in a planned way.

For other breeds, farmers buy bucks mostly from vendors, mostly from India, irrespective of the breeds or use their own replacement stock available in the community. Selection is not practiced even for male bucks. A few farmers do purchase breeding bucks from government or private commercial farms. Base flock are of mixed type and purebreds of any breed are rare except for Khari breed in some isolated mid-

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[4] Sapkota s. et al (2016). *Boer Goat Production Performance, Constraints and Opportunities in Nepal.* Imperial Journal of Interdisciplinary Research (IJIR), Vol-2, Issue-12, 2016

[5] *Adhikari D. et al (2013). Performance of Boer crossbred goats in the conventional raising system in mid-hills of Nepal. The proceedings of the national workshop on research and development strategies for goat enterprises in Nepal, NARC.*

hill districts (e.g. Khari is still available in Myagdi and Tanahun) among NLSIP district. The rest of the goat population is of mixed breed mostly crosses with Jamunapari breed.

In this context, we propose that Nepal should commence a robust goat breed improvement program at the cluster levels so that all promising meat type breeds are promoted and commercialized for achieving the sufficiency in meat. Similarly, in selected areas, dairy goat breeds such as Saanen should be promoted. The broad national strategies for the development of goat sub-sector in the country are as follows:

5.2.2 Broad national objectives and strategies

- Develop different meat type goat breeds suitable to Nepali agro-climatic environment
- Evaluate and maintain appropriate blood level of exotic breeds for maximum meat productivity
- Promote dairy goats in the long run

For achieving national level broad objectives the following national strategies need to be adopted:

i. Transform government/NARC farms as open nucleus breeding herds of elite stocks through partnership with private sector. Maintain best performing animals in these elite herds.
ii. Adopt breed specific selection adopting performance recording system in clusters first. Once robust LIMS is in operation, data for selection within a breed could be pooled at the national level
    - Selection program for Sirohi crossbred goats with upgrading plan using bucks of Ajmeri breed in mid-and far western states of the country
    - Selection program for Terai (native) goats using bucks of Native breed in eastern Terai foot hills.
    - Selection program for Boer crossbred goats with upgrading plan using bucks of Boer breed in selected clusters of Terai and mid hill physiographic regions.
    - Promote dairy breeds (Saanen and its crossbreeding program) in certain pockets for niche value products
    - Selection program for Sinhal in high Mountain areas.
    - Selection program for Chyangra incorporating traits for “Pashmina production)
iii. Define and maintain three level of herd structures – Nucleus breeder herd, multiplication herds and production herds
iv. Integrate production and productivity records of these cluster herds into LIMS
v. Promote artificial insemination in breeder herds for quick genetic gain (Boer, Sirohi, Khari and Saanen)
vi. Evaluate breeds’ performance by blood level and recommend appropriate blood level to be maintained in multiplication herds
vii. Distribute breeding stock from multiplication herds to production farms

5.2.3 NLSIP specific strategies

It may not be practical for NLSIP to work with all breeds for achieving genetic improvement. Therefore, NLSIP will strategically innovate and demonstrate performance recording system at the community cluster level of its project districts for the establishment and operation of breeder and multiplication herds for production of breeding stocks of goats. These clusters are identified based on existing goat population, presence of commercial farms and state level interaction workshop recommendations.

Goat Breeder herds**:** A breeder herd of about 2,000 does would be established by registering female lines of government goat farms, selected commercial farms (larger farms where mating is manageable as per breeding plan) and outreach sites of the government/NARC goat farms combined. NLSIP will consider first for swift multiplication of Boer breed. NLSIP will develop breeder herds by providing 100% Boer buck and/or semen of different lines to breed the genetically superior females (does) identified from the PPRS established in the clusters see below). Initially, one breeder herd cluster will need at least 60 bucks to successfully mate about 2000 + does. NLSIP will target to this number of mother does to 2,000 by the end of year two. The government goat farms will have open nucleus herd that will bring in elite goats from farmers and *vice versa* for maintaining the breeder herds. Farmers will be trained and incentivized for retaining the progenies so that recording and evaluations is not severely compromised due to frequent sale/turnover of animals in the register.

In the similar manner, NLSIP will also develop breeder herds for Khari and Chyangra.

Thus, NLSIP will work for three breed specific program. The demonstration in the initial years will be in the following breeds and clusters.

i. **Selection program for Boer crossbred goats with upgrading plan using bucks and/or semen of Boer breed.**
   Proposed locations for breeder herds are:
      Site 1. Morang and Sunsari
      Site 2 Makawanpur and Chitwan

In these two sites. Farmer groups and district level associations of the Boer goat will be in the lead in cluster program management. VHLSSC Morang and VHLSSC Makawanpur (along with DLSUs will provide technical support.

For these two sites, NLSIP will import Boer bucks of 100% blood level from appropriate country. Availability of 100% bucks within the country is scarce.

ii. **Demonstrate genetic improvement through selection in Khari breed**
   Proposed site: Myagdi distric**t**

For this cluster, ARS (goat Bandipur and DLSU Pokhara will provide technical support**.** If needed some flocks form Kaski and Tanahun can also be added in the Performance record register.

iii. **Selection for Chyangra incorporating traits for "Pashmina production)**
   Proposed site: Mustang district.

For this cluster (NLBO and DLSU Pokhara will provide technical support.
The selection system should incorporate the following or part thereof among the suggested important genetic traits listed in Table 28 below:

Table 28. Some important genetic traits for selection programme of Chyangra

Genetic traits of interest	Nepali mean	Nepali top figures	Potential (outside)
Growth rate			
Birth weight			
Adult weight (kg)	25	40	
Inner coat color (Pashmina)	Preference for white		
Pashmina yield/animal (gm)	About 200	325	500
Staple length			
Diameter (micron) (smaller the better)	19	15 -17	17 – 30

Goat Multiplication Herds: The seed animal produced in the breeder herd stated above would be distributed for further multiplication and for maintaining significant crossbred population of the outperforming exotic blood level. The objective of the multiplication herd is to provide production farms with breeding stocks of defined blood level of the breed in question. Performance recording and evaluations of goats in multiplication herds will follow the same scientific principles described for breeder herds – based on the evaluation in the breeder herds' performance a breeding plan in hand will be there for maintaining the exotic blood level of multiplication herds that suits the best in a given agro-ecological situation.

It is advised that multiplication flocks be established in the following 11 of the twenty most goat populous districts of the country (see table xx on assessment)

Jhapa, Morang, Sunsari, Udayapur, Dhanusha, Makawanpur, Kavre, Chitwan, Rupandehi, Syangja and Bardia.

In addition: NLSIP will consider establishing one Chyangra multiplier herd in Manang district.

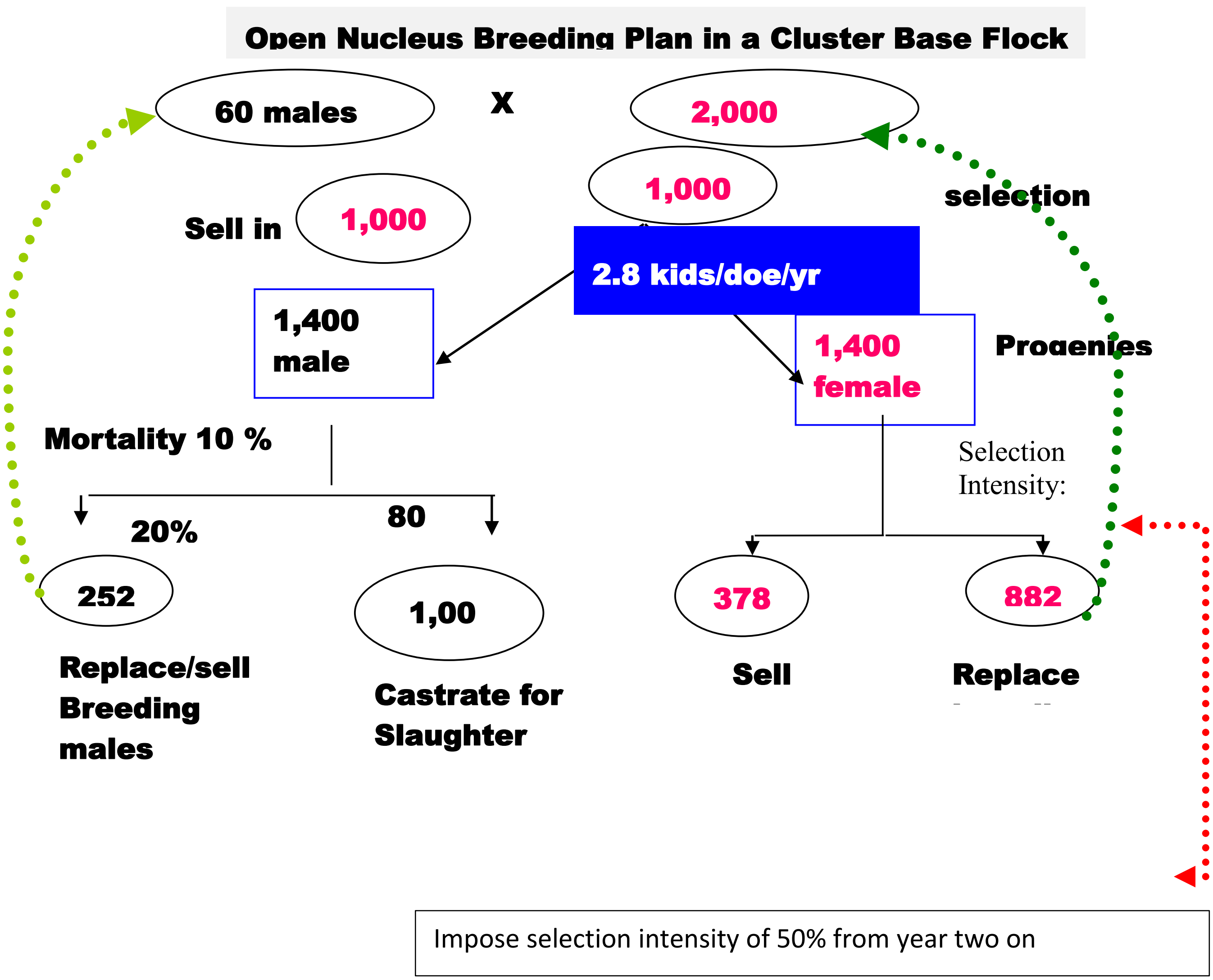
Multiplication herds will be established once breeding stocks from Breeder herds are available for sale. Thus, for evaluation of performance records of the multiplication herds, respective DLSUs and VHLSSC will provide the technical support once they receive trainings from NLSIP in the management of PPRS and Data analysis at the cluster level.
Technical description:

Selection of breeds and breeding stock for profitable goat meat production should be based on four primary production traits namely; growth rate, reproductive rate, adaptability to the environment and carcass value. Breed improvement program must take into account two variables to achieve the expected response through selection; one being the heritability of the trait and the other being selection differential. The former is defined as *the proportion of phenotypic variation in a population that is attributable to genetic variation among individuals* and the latter as *the difference between the average of selected individuals and the average of the population they were selected from*. Heritability estimates for body weights of Hill goats are moderate to high ranging from 0.22 for 36 weeks to 0.53 for birth weight. Moderate to high estimates of heritability indicated that the additive genetic variation exists and that selection should be effective for improving these traits relatively quickly.

Heritability estimates for litter size are low but the estimates for litter weights are moderate suggesting that selection may be effective for improving these traits. Weight gain, maternal abilities and feed efficiency have significant genetic heritability. Weaning weight is a function of birth weight and maternal ability (maternal ability includes dam' milk yield plus her maternal instinct). In this context weaning weight doesn't give a measure of the kids' performance unless kids are fed on forages. **Weaning weights give a measure of the kids' performance dependent on the maternal abilities of the doe.** For making application of this parameter farmers friendly, we are proposing to measure the 3-month and five-month weights of the kids.

Community level participatory planning is required to commence the PPRS for genetic improvement of goat in upgrading native breeds with exotic Boer breed through performance recording and evaluation of different Boer blood level. Based on the outcome of this activity, NLSIP will support DLS to scale up similar models in other breeds and locations in mid hill districts and further expansion of Chyangra herds beyond Mustang districts.

Figure 37. A model performance recording and breeding plan for selection of goats in a community (Constituting Government farm + farmer at outreach sites + commercial farms)[6]



[6] *Adapted from Author's work for community initiated genetic improvement of goat for Heifer International Nepal, 2012*

Parameters for Doe Selection:

The PPRS program on goat will focus on selecting does using a simple index of *live litter-weight at three month.* In selecting goats for meat production, the parameters would be (a) growth rate, (b) adaptability to environmental and production conditions, and (c) reproductive rate. The best way to increase adaptability is to select for the desired traits under actual local production conditions. Therefore, the breeding stock will be selected from animals that are maintained under the same natural conditions in which their progenies would be raised. As agro-climatic conditions differ from Terai to mountain from east to west, the best choice for breeds will be based on farmers choices evolved by agro-ecological locations through the selection program.

2000 Does
90-day litter weight produced by a doe

Mean

Nannies Culled | **Nannies Selected**

Retain top 50% among nannies for further breeding

Sub-population analysis

- Nannies at first kidding
- Nannies at 2^{nd} – 10^{th} kidding

Parameter for Breeding stock selection (male and female)

Plan:

- **Select individual from among progenies based on live weight at**
- **five month – (for male and female both)**
- **Castrate lower 80 % individuals**
- **Select males as breeding bucks to multiplication and production herds for exchange/distribution**
- **Select 50 % females kids for replacement/ multiplication**

Criteria for culling of goats

Based on performance records and general examination for health, this has to be undertaken once every four months. Some criteria for culling of females and males may include the following, subject to participatory discussion with the farmers:

Females

Review performance record results (data of all recorded does in ascending /descending order and identify does that are out performing in terms of three month litter weight of the kids a doe produced);

- Set cut off line on three- month litter weight in Kg produced by a doe;
- Consider twinning frequency and cull if it misses to produce twins for three kiddings in a row;
- Barren female--missed three seasons in a row;
- Bad teats or udders--too big or too small (mastitis);
- Bad mouths--smooth or broken mouth or over- or undershot jaw; and
- Structural defects--bad feet and legs or back and other morphological defects, if any.
- Severe health problems including infertilities
- Long kidding interval, > 10 months

Males

- Body weight standard by age;
- Unsound buck from mating performance ground;
- Unsound buck from genetic grounds, any morphological deformity of heritable nature;
- Demonstrated infertilities;
- Bad testicles - too small or infected (epididymitis); and
- Unthriftiness - due to old age or disease.

Some recommended activities for initiating a PPRS in a Community Cluster:

a) Identify the cluster with > 2000 does and enlist participating households in the districts listed above.

- Organize group meetings at several places. Form new groups if necessary to meet the required goat numbers.
- Involve large commercial farms
- Appraise them in details of the objectives, activities, brief methodology, outcomes and benefits of the selection program and establishment of breeder/multiplication herds

b) Train participating farmers: to demonstrate the process of data recording and to ensure they can do it themselves.

- Filling format of individual goat
- Data recording: parameters and schedule
- Demonstrate the methodology of performance recording (tagging, weighing, recording of kidding dates, health records, mortalities etc.)

c) Organize groups/cooperatives as a cluster and set the framework of goat population for recording

- Prepare the list of clusters and sub clusters of participating households. If farmers are already in groups the process will be simple.

- Identify responsible persons among farmers to continue identification of animals and tagging for performance recording. Ensure that within a year at least 1000 does are included in the inventory for recording.

Performance Recording and Data Generation

i. **Define individual animal's breed of the base flock of the farmers participating in this program**

- Majority are J*amunapari crossbred* in the mid-hills. For example, if farmers opt for upgrading base flock with Boer, begin crossbreeding with the selected does of all major breeds prevailing there in the cluster (irrespective of breeds of female lines in the base flock). The project will provide 60 Boer bucks of different lines for upgrading the base flock. F1 generation stock of 50% blood level of males and females will then be taken to multiplication herds. Performance evaluations for different blood levels will continue in the breeder herds.
- If farmer opt for *Khari* breed, go for the same for both male and female lines. If farmers have decided to innovate selection program for Khari crosses, other exotic breeds such as Boer *'Ajmeri', 'Barbari' 'Sanen'* bucks must be excluded from mating and it is better to exclude nannies with more than 50% blood level of exotic breed from performance record inventory.
- For unique identification, tag the animal and fill individual animal's record card in duplicate (make two copies) immediately requesting the owner to recall all retrospective information of that particular animal as far as possible
- Keep one card at the farmers' house and the other at the site office for entering the data into the computer.

ii. **Plan for materials/service/ inputs that have to be shared among households.** Some of the examples of such inputs are:

  - Weighing machine: enlist households a weighing machine will be shared among. For example, a weighing machine will be enough for 10 households.
  - Registers for group/committee minutes.

iii. **Identify key facilitators from among the community members**: The facilitators could be schoolteachers or high school graduated farmer who could voluntarily assist data recording task and help farmers in the event of need.

iv. **A computer for data management of performance records.**

v. **Improve breeding, feeding, husbandry and health practices as per needs in the cluster.** Arrange one breeding buck for *every* 30 - 40 goats. Before buying new buck investigate its body weight gain trend retrospectively and its mother's twinning rate, kidding interval and ability to foster kids.

Important: it is extremely important to package trainings and inputs on feeding, health care and husbandry practices in the clusters of goat genetic improvement programs.

Chapter 6
Implementation of the strategic plan

6.1 Introduction

This chapter provides a plan for implementing the strategic plan developed in Chapter 6. It first begins with identifying the roles and responsibility of different institutions and personnel that will be involved in implementing the strategic plan. It then develops an execution plan for the programmes proposed under the strategic plan including technical details in the form of SoP for key activities. Finally, it identifies the manpower requirement and suggests a plan for building the capacity of people at all levels. Other policy and legal aspects related to the implementation of the strategic plan such as breeding policy, identification and registration of animals, development of information system, etc. are dealt with in Chapter 8.

6.2 Identifying the roles and responsibility of stakeholders

The key stakeholder and personnel who will play key roles in implementing the strategic plan include: Department of Livestock Services, PMU of NLSIP, DLSUs of NLSIP, NLBO and LBOs, Project Management Committee of the programme, Core Project Management Team at NLBO, LSSs, Cooperative Societies and Producers Organisations, AI technicians, milk recorders, project supervisors and managers, and Nepal Agricultural Research Council. A brief description of the role and responsibility of these key stakeholders is described below.

6.2.1 Implementation arrangement under NLSIP

A Project Monitoring Unit (PMU) at central level and four Decentralised Livestock Service Units (DLSUs) at cluster level will have the overall responsibility of NLSIP implementation. The project will work with Veterinary Hospital and Specialised Service Centres (VH&LSSC) at the district level. Under the guidance of respective DLSU, VH&LSSC will be directly involved in the implementation of all project activities of NLSIP with the support of municipal level Livestock Service Section (LSS) in their respective district.

To facilitate project implementation, there will be a Project Steering Committees (PSC) at the centre, three layers of Dialogue Platforms (DP) at the centre, state and district and two layers of Technical Coordination Committees at centre and State. The details of the composition and role of these committees are provided in the Project Implementation Manual of NLSIP. The PSC will review project progress, approve project guidelines and provide strategic and policy guidance to the project, whereas the DP will help build productive partnerships between the producers and buyers and provide guidance in coordination and service delivery. The Project Coordination Committee at the centre will provide technical support and help maintain coordination between NLSIP and DLS entities (central, provincial and district) for effective project implementation and service delivery, whereas the respective state and district coordination committees will have a similar role at the respective state and district level. The DP at the state and district level will help build productive partnerships between the producers and buyers and provide guidance in coordination and service delivery at the respective state and district level.

While the PSC, DPs, and TCCs will coordinate and monitor overall project activities at different levels, to monitor closely and provide technical guidance on a continuing basis for implementing the proposed project activities of breeding and to achieve the set targets, we think it necessary to make NLBO as the lead implementing agency for all breeding programmes and constitute a management committee for livestock breeding chaired by the Project Director, NLSIP with the following composition. We suggest naming this committee as Livestock Genetic Improvement Management Committee (LGIMC). The LGIMC will be responsible to the PSC.

1.	Project Director, NLSIP	Chairman
2.	Chief Livestock Development Officer, NLBO	Member
3.	A specialist from the National Livestock Resource Management and Promotion Office	Member
4.	A representative from the Nepal Agriculture Research Council	Member
5.	One representative of VH&LSSC	Members
6.	One representative of Municipalities	Members
7.	Team Leader, Project Implementation Unit at NLBO	Member Convener

It is also proposed that a Livestock Genetic Improvement Unit of four persons one responsible for implementation of Performance and Pedigree Recording and Genetic Evaluation, second responsible for semen production, procurement, import, and distribution, third responsible for AI expansion and monitoring, and the fourth responsible for data processing be constituted to coordinate all project activities related to livestock breeding under NLSIP.

A brief description of the role of Livestock Genetic Improvement Management Committee and Livestock Genetic Improvement Unit and also the role of PMU, DLSU, VH&LSSC, LLS, Supervisors, AI Technicians and Milk Recorders in relation to implementing all breeding projects proposed is given below:

6.2.2 Role of Livestock Genetic Improvement Management Committee

The Livestock Genetic Improvement Management Committee (LGIMC) will jointly be responsible for the implementation of all breeding projects approved under NLSIP. Specifically, it will:

- Prepare a plan and implementation strategies for approved projects
- Approve budget and expenditure
- Prepare MoU to be entered with organisations and individuals to execute the activities planned under approved projects.
- Monitor implementation of project activities and take corrective actions wherever necessary
- Review progress and be responsible for achieving the target set
- Review manpower needs and propose recruitment of additional manpower
- Develop plans and implement programmes for building the capacity of supervisory and managerial staff implementing various projects.
- Identify areas of research to overcome the challenges faced and support research in priority areas
- Plan for the sustainability of the projects beyond the NLSIP period

The LGIMC shall meet as many times as required, but at least once in three months to review all activities and take corrective actions.

6.2.2 Role of Livestock Genetic Improvement Unit

The Livestock Genetic Improvement Unit (LGIU) will prepare and execute all breeding programmes under the supervision, direction, and control of the Management Committee. The LGIU) will have four persons one each having background in animal breeding, semen production, AI delivery, and data processing. The specific responsibility of LGIU) will include:

- Prepare a detailed proposal in consultation with PMU and four DLSUs for three performance and pedigree recording and genetic evaluation programmes proposed with details targets and timelines and get them approved by LGIMC.
- Prepare a detailed proposal for the strengthening of semen station of NLBO at Pokhara and get it approved by LGIMC
- Prepare a detailed proposal for AI expansion in consultation with PMU, DLSUs and VH&LSSCs and get it approved by LGIMC
- Prepare an execution plan for implementing three PPR and genetic evaluation programmes, the semen station strengthening proposal and AI expansion programme.
- Develop training material and organised training programmes for AI technicians, milk recorders, supervisors, staff of VH&LSSC and LSS for carrying out all activities planned under PPR and genetic evaluation.
- Identify bulls to be put under test programmes, and arrange import of semen doses of young bulls to be put under test programme as well as of top progeny tested semen for producing young bull calves to be put under test.
- Prepare a schedule of test doses distribution and organise its supply.
- Monitor all project activities related to PPR and genetic evaluation, semen station strengthening, and AI expansion
- Carry out breeding value estimation of bulls and recorded females.
- Organise nominated mating and procure calves
- Undertake periodic review of all project activities.

6.2.3 Role of PMU

The PMU shall:

- Provide the necessary funds as per the approved programmes
- Provide the necessary technical help to implement the project activities
- Carry out an annual independent evaluation of the projects

6.2.4 Role of DLSU

The DLSU shall:

- Assist the Livestock Genetics Improvement Unit in:
    - Preparing the detailed proposal on PPR and genetic evaluation and expansion of the AI network in the cluster area of respective DLSU
    - Identifying municipalities which could be included in PPR and genetic evaluation programme
    - Identifying cooperative societies that take responsibility of engaging AI technicians and milk recorders for PPR and genetic evaluation programme
    - Helping to identify infrastructural gaps at the LSS of the selected municipalities to store LN and semen doses as well as to carry out milk component analysis
- Facilitate and coordinate project activities among various implementing partners
- Assist in identifying and resolving problems related to data collection
- Organise training programmes of AI technicians and milk recorders for implementing project activities

- Organise training programmes for supervisors
- Monitor the implementation of the project activities related to PPR and expansion of AI network
- Assist in project evaluation activities

6.2.5 Role of Municipalities/Rural Municipalities

The role of Municipalities in the genetic improvement of livestock will mainly be implemented through its livestock service Section or its service centers. Some of the important roles of municipalities are summarized below:

- Keep an inventory of livestock genetic resources: strategize their promotion, conservation and economic utilization within the municipality.
- Keep an inventory and regulate the services of public, private and cooperative sector service providers including para-vets and inseminators. Provide them level ground service opportunities for running their service businesses.
- Co-plan and co-work with neighboring municipalities when needs arise such as sharing of resources for certain activities. For example, the establishment and operation of an LN and semen storage and distribution hub.
- Appropriate/allocate financial and other resources for genetic improvement of livestock.
- Mobilize LSS for performance recording and progeny testing activities.
- Mobilize POs in genetic improvement programs
- Participate in DLSU planning events and facilitate activity planning and implementation by coordinating the key stakeholders of the municipalities
- Allocate common property resources including public land for livestock development and veterinary service related programs including operation of community breeding centers, livestock markets, and others
- Identify and coordinate the roles of key stakeholders their responsibilities for the production, processing, and marketing of healthy and quality livestock products
- Identify key issues of livestock breeds and their qualities in relation to the market and consumer demands for inclusion of value chain development. Co-work with actors such as producers, processors, buyers, suppliers and articulate possible solutions including those requiring collective action and/or requiring local government support, working out actionable agreements; concrete partnerships between specific producer organizations and buyers; concrete commitments by governments to execute prioritized actions.
- Facilitate and coordinate the marketing of breeding stocks for the dissemination of good genetics.
- Monitor field-level programs
- Participate in NLSIP programs implementation and project events such as Stakeholder dialogue platforms, program planning
- Develop joint annual programs with DLSUs

6.2.6 The roles and responsibility of the State Government

The Ministry of Land reform, Agriculture and Cooperative in each state will the focal institution for promotion, conservation and economic utilization of livestock genetic resources of the state. The programs on improvement of livestock genetics will be executed through the Directorate of Livestock and Fisheries Development and its network at the district level (VHLSSC).

The programs related to livestock genetics improvement will be carried out by Directorate of Livestock and Fisheries Development through the mobilization of VHLSSC at the district level and LSS at the Municipality level. All the plans and programs of genetic improvement will be converged at the Directorate, respective LBO or at NLBO and respective DLSUs. The annual plan will be discussed and endorsed by the State level dialogue platform. NLBO will coordinate at the national level with financial resources from NLSIP or DLSUs. NLBO will also coordinate with LBOs for specialist service in animal breeding discipline including data analysis. This arrangement will be agreed and endorsed through the dialogue platform.

The specific roles and responsibilities may include to:

i. Build technical capacity of respective staff of Municipal and VHLSSC in livestock breed improvement, and conservation and utilization.
ii. Develop joint programs with NLSIP, NLBO, government farms NARC and Agricultural Universities.
iii. In partnership with NLSIP undertake Specialist level training for data management and analysis so that key specialists are available at VHLSSC and the Directorate of Livestock and Fisheries Development of the state.
iv. Carry out, in partnership with NLSIP, mid-skill training for PPRS operation for VJLSSC and municipal technicians, private paravets/inseminators, lead farmers selected by POs for record keeping, milk analysis, data entry, monitoring, data storage, minor data editing, and reporting.
v. Conduct training of trainers (TOT) for producing adequate trainers to run the program at the grass-root level.
vi. Assist and mobilize NLBO experts, DLS trainers, and TOTs to conduct intensive on-site training to participating farmers.
    a) Performance record keeping and reporting.
    b) Milk analysis records.
    c) Internal audit system on data recordings.
    d) Husbandry practices.
    e) Breeding practices.
    f) Health care practices.
vii. Procure and co-ordinate production, storage, transport and distribution of liquid nitrogen to all AI centres operating in the state.
viii. Establish and operationalize systems in regional government/NARC for production of elite breeding stocks important for the state.
ix. Co-work with State Level Dairy Development Boards (to be formed in future)

Specific to NLSIP: In partnership with NLBO, the DLSUs will be responsible for day-to-day project management and to facilitate and coordinate project activities among various VHLSSCs, LSS of the municipalities and milk cooperatives and POs for project implementation at cluster level and reporting to PMU and the Federal government. They will act as a regional representative of the Project Management Unit. They will be responsible for:

- Mobilizarion of the VH&LSSC and municipalities in annual planning, budgeting, implementing and monitoring at cluster level in close coordination NLBO, LBO and Directorate of Livestock and Fisheries Development
- Coordination to provide technical consulting service in need and co-work with Municipal LSS, VHLSSC in support of implementation, supervision, and monitoring of breed improvement activities
- Playing a key role in the establishment and operationalization of provincial and district level stakeholders dialogue platforms – table, receive endorsement/consensus from DP and execute the genetic improvement programs
- Ensuring that PPRS computer system is operational and is being used effectively by the end users specifically, VHLSSC, LSS, POs, and the farmer beneficiaries;
- Ensuring that the crosscutting issues like women participation, environmental and social safeguards and food safety compliance, and good governance are embedded in the breed improvement programs
- Ensuring effective implementation and promote public awareness about genetic improvement programs
- Ensuring that the financial resources and inputs indicated in the AWPB are delivered in time
- Facilitate joint monitoring at the field level;

6.2.5 Role of VH&LSSC

The VH&LSSC shall:

- Assist the Livestock Genetics Improvement Unit and local DLSU to identify municipalities, AI technicians and milk recorders for the PPR project.
- Help in identifying infrastructural gaps at LSS of the municipalities selected for the PPR project
- Assist in organising training programmes of AI technicians and milk recorders for NLSIP activities
- Assist in identifying and initiating AI services in wards where AI services are currently not provided
- Facilitate implementation of NLSIP activities
- Create awareness among farmers on NLSIP activities

6.2.6 Role of LSS

The LSS shall:

- Provide the required LN to AI technicians
- Distribute test doses for test AI, progeny tested doses for nominated AI for production of young calves and general doses for routine AI
- Collect filled up formats from AI technicians and milk recorders and enter data through a desktop/tablet, etc.
- If the LSS is identified for installing a milk analyser, provide the required facilities at LSS for setting up the milk analyser and then receive milk samples from milk recorders and carry out milk component analysis of all samples received from the field.

6.2.7 Role of AI Technicians

The AI technician shall:

- Carry out AI following SoP
- Ear tag all animals that are inseminated
- Fill up the AI format or enter data through smartphone/tablet, etc.
- Follow up each AI for PD and calving
- Report calving through filling the calving format or enter data through smartphone/tablet
- Ear tag new born female calf and register it through entering data in the calving format
- Take first body measurement of the female calf to estimate birth weight
- Carry out nominated AI if entrusted and follow up for PD and calving
- Ear tag new bull calves born out of nominated AI
- Assist in implementing any other activities assigned under NLSIP

AI technicians shall report to the assigned supervisors.

6.2.8 Role of Milk Recorders

The milk recorder shall:

- Carry out monthly morning and evening milk recording of the assigned farmers as per the monthly milk recording schedule and SoP
- Collect milk sample at morning milking and arrange passage of samples to the assigned milk analyser centre probably through AI technicians
- Fill up milk yield data in the milk recording format or enter data through smartphone/ tablets, etc.
- Follow up female calves for 6 monthly body measurements till their calving.

Milk recorders shall report to the assigned supervisors.

6.2.9 Role of Supervisors

The supervisor shall:

- Supervise the assigned AI technicians and milk recorders
- Carry out surprise checking of at least 20 percent milk recordings
- Coordinate logistics of milk sample movement from villages to the place of milk component analysis.
- Check all calving reported and all registered female calves
- Conduct random checking of female calves body measurements
- Carry out typing of daughters born in their first lactation between 60-120 days post-calving
- Coordinate nominated mating and male calves procurement
- Ensure timely movement of all formats from AI technicians and milk recorders or in case of direct data entry through tablet/smartphones to check the regularity of data entry
- Assist in the screening of bull calves for diseases, correct parentage, genetic disorders, etc.

Supervisors shall report to the designated coordinator of respective VH&LSSC.

6.3 Execution plan for breeding Programmes

LGIU in coordination with VH&LSSCs, DLSUs and PMU will execute the three proposed PPR and Genetic Evaluation Programme viz. HF crossbreds, Jersey crossbreds and Murrah crossbreds following the programme guidelines provided in section 5.3.1.2 of Chapter 5 and adhering to the Standard Operating Procedures (SoP) given at Annex 2.

Besides, LGUI under the guidance of PMU will undertake the activities related to the strengthening of the semen station of NLBO on the lines of suggestions made in section 5.3.2.1 of Chapter 5. NLBO will adhere to the standard operating procedure of semen production and processing given at Annex 3.

In addition, LGUI in coordination with VH&LSSCs, DLSUs and PMU will prepare an AI expansion plan on the lines suggested in section 5.3.2.3 of Chapter 5. It will organise training programmes for new AI technicians and ensure all AI technicians to follow the standard operating procedure given at Annex 4.

On the formal approval of the three PPR and genetic improvement programmes, the semen station strengthening proposal and the AI expansion proposal by the Livestock Genetics Improvement Management Committee, the PMU will initiate the process of appraisal and put up them to PSC for approval. Once the proposals are approved by the PSC, the PMU will issue a sanction letter and execute an agreement with NLBO for execution of all programmes.

NLBO in coordination with VH&LSSCs, LSSs, DLSUs and PMU will execute and monitor all programmes as detailed in the approved proposal.

6.4 Human Resource Development

Placing of required human resources and building their capacity are important for the successful implementation of all breeding programmes proposed under NLSIP.

There will be about 30 personnel from DLS (VH&LSSCs, NLBO and LBO), PMU and DLSU, NARC, National Livestock Resource Management and Promotion Office (NLRM&PO), and private sector to train and develop as a core team of experts for implementing and sustaining the breeding programmes. This core team needs to be developed with organising appropriate training programme within and outside the country to evolve and adopt the best practices suitable for the local conditions. The key senior officers of PMU and DLS should also be exposed to best practices in animal breeding through short overseas exposure visits.

Apart from the team of core officers, there will be some 300 AI technicians, 300 milk recorders and 50 milk analyser cum data processing assistance to be engaged and trained in the activities related to performance and pedigree recording and genetic evaluation. Specialised training programmes will need to be developed for each category of personnel and detailed training manuals need to be prepared which can be used for training and later for reference. In addition, some 1900 new inseminators need to be trained for the entire country, of which NLSIP should aim for providing training to some 500 new inseimators within the project period.

Chapter 7
Policy and Legal framework and MIS for Genetic Improvement of Livestock

7.1 Introduction

This chapter deals with certain policy and legal issues that need to be addressed to improve the implementation of genetic improvement programmes. Identification and registration of an individual animal is a key prerequisite for any genetic improvement and health programme. If all animals need to be identified in an area, for example for controlling FMD in an area, a mandatory system of identification based on legal support is necessary. The country has vast livestock biodiversity. The numbers of many local breeds of livestock are rapidly declining and many of these breeds have reached under the category of the threatened breed and a few of them are at the verge of being declared endangered. Some of these breeds are very important for the livelihood of people living in the country's harsh environments. They need to be conserved and developed further to continue to keep them relevant to the farmers who keep them. In all endeavors of breed development and improving veterinary healthcare, collecting required data and providing relevant information to all stakeholders is critical. This chapter addresses some of these issues.

7.2 Identification of animals

Animal identification in livestock is done for many purposes, they include:

- Enhancing the ability to trace animals for the purpose of disease prevention and control, prevention of livestock stealing, rescuing animals in disaster-struck areas, payment of subsidy and preventing fraud, complying with Sanitary and Phytosanitary (SPS) standards set by importing countries, etc.
- Enhancing the ability to trace animal products from farms to consumers and to respond promptly and effectively to prevent contaminated or poor quality products reaching consumers. It may facilitate food recall in case of contamination in the value chain
- Performance recording of the individual animal to assist the farmer in day-to-day management, take culling decision and plan investment.
- Genetic improvement of animals through identifying superior animals and mating them to produce the next generation of animals.
- Generating useful statistical information on production and productivity of different types of animals in different production environments and areas as well as on factors that influence production.
- Insuring livestock.

If the purpose of identification is disease control like FMD, Brucellosis all animals need to be ear tagged and legislative support becomes imperative for effective control and prevention of diseases. If the purpose is performance recording and genetic evaluation, all animals of only the participating farmers need to be ear tagged.

Individual animal identification and registration involve uniquely identifying the animal, its owner and keeper and collecting certain data about the animal, the owner, and the keeper. Individual animal identification involves applying an ear tag with a unique number to an animal. It is recommended to use 15-digit ISO code - 3 digit country code and 12 digit ID code within the country - for identifying an animal. Within the country, the country code is not printed on the ear tag i.e ear tag number is usually of 12 digits. It is advisable not to use any breed, region code in the animal number. The number should be just a serial number within the country. A check digit should be added i.e 11 digits as a serial number with the last digit as a check digit derived from first 11 digits. Registering owner involves assigning a unique number to the owner and collecting certain owner information. Likewise, registering keeper involves assigning a unique number to the keeper and collecting certain information about the keeper. Often the owner and keeper may be the same.

It is advisable to develop a standalone computer application for identification and registration that includes: animal identification and registration, owner identification and registration, keeper identification, and registration, and the movement of animals. Such a standalone system of identification and registration can be used by other applications developed for performance and pedigree recording, genetic evaluation, ration balancing, veterinary health care including treatment, testing, diagnosis, and diseases outbreaks reporting, etc.

If the animal identification and registration system is to be developed for diseases control then a legislation support is absolutely required, but if it is for the purpose of performance recording and genetic evaluation, it could be voluntary.

7.3 Breeding policy

The country needs a regulatory mechanism for production and distribution of germplasm and the adoption of scientific processes for the implementation of genetic improvement programmes.

Based on the provisions of the Animal Health and Livestock Services Act, 2055 (1999), and likely amendments of this act in future, NLSIP has assigned Nepal Veterinary Council to formulate Animal Breeding Policy for the country. The major components of the act include: (a) quarantine; (b) husbandry and breed improvement; (c) disease notifications, and (d) animal welfare. It is noteworthy for immediate further action that Animal Health and Livestock Service Regulation has been formulated with regard to governance of the quarantine component (a) only, rest of the components (b, c and d) are still confined to act provisions, therefore, lack elaborated regulatory functions on husbandry and breed improvement, disease management and animal welfare components. The provision of this act can be used to enforce the new breeding policy being drafted. A few recommendations that may help in drafting the new breeding policy are given below:

- In hill regions, HF crossbreds should be bred with the semen of HF bulls having HF inheritance more than 75%.
- The majority of HF crossbred bulls used for semen production should be produced using semen of bulls proven locally and a small percentage by imported proven semen.
- In hill regions, Jersey crossbreds should be bred with the semen of Jersey bulls having Jersey inheritance more than 75%.
- The majority of Jersey crossbred bulls used for semen production should be produced using semen of bulls proven locally and a small percentage by imported proven semen.
- A crossing of HF crossbreds with Jersey semen or vice versa should be discouraged
- In the Terai region, HF crossbreds should be bred with semen of HF bulls having HF inheritance not more than 75%.

- In the Terai region, Jersey crossbreds should be bred with semen of Jersey bulls having Jersey inheritance not more than 75%.
- Initially 75% HF/ 75% Jersey exotic inheritance crossbred bulls could be produced inseminating top recorded HF crossbred females/Jersey crossbred females with imported proven semen of Gir or Sahiwal and later a systematic programme could be developed to produce 75% HF/75% Jersey crossbred bulls.
- A breed conservation programme should be developed for Lulu and Achhami cattle and Parkote buffalo breed.
- In the Terai region a systematic Hariana breed development programme should be undertaken
- All buffaloes of the country should be bred with semen of Murrah bulls having no restriction on Murrah inheritance.
- Majority of Murrah bulls should be produced using semen of bulls proven locally and a small percentage by imported proven semen.
- A breed conservation programme should be developed for Parkote buffalo breed.

Another area that needs attention is the involvement of farmers in breed development. There are two policy documents that propose to encourage farmers to form breed associations. One is Agriculture Development Strategy (2015 – 2035 AD) and the other is National Dairy Development Policy 2064 Bs (2008 AD). Agriculture Development Strategy of the government of Nepal envisions roles of value chain development alliances (VCDAs). Producer organizations (POs) are similar institutions referred in this document ADS as VCDAs. With the emergence of POs such as milk producers' cooperatives, dairy farmer associations, goat farmers associations and federations of farmers' cooperatives in the country, it now appears feasible to develop breed associations for the development of dairy cattle, buffalo and goats of genetic merits. This will be in alignment with developing breeding associations by breeds as per the essence of the act. Clear linkage of breeding associations and research stations/Government/ University farms is necessary for performance recording, data analysis and coordinated breed improvement programs. Such provisions could be elaborated in regulation sections under this act. Similarly, National Dairy Developmet Policy envisions development of dairy cattle and buffalo resource centers in partnership with farmers' groups/associations/cooperatives and paves road for application of new technologies for enhancing milk productivity of dairy animals.

7.4 Information systems for genetic improvement

A central-level integrated management information system (MIS) is being developed for NLSIP including breeding services. For efficient implementation of breeding programmes personnel involved at various levels need information. The information needs of various stakeholders have been identified here with a purpose that while designing the application the required information of various stakeholders is incorporated in the application and the application enables the user to generate his/her required information in a user-friendly way.

The key stakeholders for performance and pedigree recording and genetic evaluation are: dairy producers, AI service providers (AI technicians, municipalities, VH&LSSC, provincial department of livestock services, central DLS, NLBO), dairy societies and dairy processors, farm consultants, policy makers, etc. It is important to identify the information needs of these stakeholders and to make provision in the application to generate the required information. Information needs of some important stakeholders are identified and listed below:

Dairy Producers:

1. Pedigree details of their animals
2. Animals that are: due for pregnancy diagnosis, to be dried off, due for calving, to be served after calving, inseminated more than three times, having sub-clinical mastitis, etc.
3. Lactation performance of their animals with respect to total milk yield, fat%, fat yield, protein %, protein yield, lactose %, etc.
4. Reproductive performance of their animals in terms of number of services per conception, calving ease, service period, dry period, inter calving period, etc.
5. Body conformation scores of their animals
6. Performance of their animals compared to average performance of animals in the area - village, district, state etc. - on key performance parameters
7. Bulls to be used for breeding their animals
8. Due date for vaccinations against specific diseases
9. Status on vaccination of their animals
10. Due date for de-worming
11. Status on de-worming of their animals
12. Animals having sub-clinical mastitis
13. Animals having foot problems
14. Animals having other chronic disease problems - TB, JD, brucellosis, milk fever, ketosis, etc.

Information needs of AI service providing organisations

Artificial insemination service providing organizations engage AI technicians to provide AI services to farmers' animals, supervisors to manage field operations, and managers to provide overall policy guidelines and support. The information needs of AI technicians, supervisors, managers are briefly described below:

AI Technicians may like to have herd/village wise information on: animals to be examined for pregnancy; animals to be dried off; animals whose calving details to be recorded; animals which may be served; animals inseminated more than three times; average fertility parameters; classification of animals in pre-breeding (less than 90 days after calving), active breeding (between 90-150 days after calving), pregnant stages, etc.

Supervisors may like to have on monthly basis village and AI Technician wise: number of AI done; number of pregnancy diagnosis carried out; number of calving recorded; semen doses used; average fertility parameters in comparison to other areas.

Managers may like to have the same information as required by supervisors, but in addition he would also like to have the same information supervise wise and for the whole organization.

NLBO

NLBO put their bulls under a test programme. In addition to what AI service providing organisations need, they would need estimates of breeding values of their bulls on key parameters such as lactation yield, fat%, fat yield, protein%, protein yield, fertility, fitness, type characteristics, etc. Specifically they may need the following information:

- Number of test doses used in progeny testing proramme bull wise in different areas;

- Bull wise information on: Conception rates, calving ease, number of calves born, genetic defect observed in new born calves etc.;
- Breeding values of bulls for growth, reproduction, production, quality, conformation, fitness and health traits.

Dairy Societies and Milk Processors

- They may like to have information in their area of operation on: dairy farms, animal numbers, productivity and production
- Season/month wise variation in fat%, protein%, lactose% and somatic cell count
- Breed wise variation in milk components and somatic cell count
- Herd/Village wise average of milk components – fat%, protein %, lactose%,
- Geographical and trend analysis of milk components
- Incidence of various diseases
- Geographical distribution of diseases

Policy makers

Policy makers may look for summarized information on the performance of dairy production sector as a whole. They would be interested to look at trends and major changes happening in the sector. They would also be interested in knowing the performance of different organizations as well as information to assess where additional investment would be necessary.

Chapter 8
Recommendations

Nepal has a very diverse and large population of cattle, buffaloes, and goats. Based on the assessment of the existing genetic resources of cattle, buffaloes and goats and the existing infrastructure and programs on the production of quality genetics and its dissemination, it is recognized that the country will greatly benefit by establishing infrastructure on performance and pedigree recording and genetic evaluation and strengthening the infrastructure for semen production and processing and AI delivery as well as that for natural service. Our specific recommendations on building the right infrastructure for production and dissemination of genetics to achieve sustainable genetic progress benefitting a large number of farmers are given below in two parts one on cattle and buffaloes and second on goats:

Recommendations for cattle and buffaloes:

1. **Genetic resources**: Crossbreds HF and Jersey cattle, and crossbred Murrah buffaloes are the mainstream breeds which are the major supplier of milk in urban areas of both the hills and Terai districts. There are also native breeds of cattle, important among them include: Lulu, Achhami, Pahadi, Khaila, Terai, and Siri. These native cattle breeds provide required draught power for agriculture operations and transport, organic matter for crop production, and fuel through dried dung. The important native breeds of buffaloes include: Lime, Parkote and Gaddi. They provide milk, meat, and manure. Besides, there is a large population of non-descript cattle and buffaloes. The country needs to set broad goals for genetic improvement and develop appropriate breeding policies and strategies for achieving the set goals and steady genetic progress in these populations.

2. **Setting national goals for genetic improvement**: Based on the past trends and the current assessment of the infrastructure, the following broad national targets for breeding activities have been proposed:

   (i) Raise the percentage of breedable cattle inseminated from the current level of 14.1 to 30 by the year-end of NLSIP and to 50 percent by the end of 15 years;

   (ii) Raise the percentage of breedable buffaloes inseminated from the current level of 2.2 to 15 by the year-end of NLSIP and to 40 percent in 15 years;

   (iii) Raise the number of AI to be done from the current level of 438 thousand to 1010 thousand in cattle and from 128 thousand to 837 thousand in case of buffaloes by the year-end of NLSIP and to 1925 thousand in case of cattle and to 3614 thousand in case of buffaloes by the end of 15 years to achieve the set target of percentage of cattle and buffaloes to be inseminated;

   (iv) Continue to import about 15 percent of the total semen doses during the NLSIP period and 10 percent thereafter;

   (v) Raise the domestic semen doses production from the current level of 561 thousand to 945 thousand in the case of cattle and from 98 thousand to 783 thousand in the case of buffaloes by the year-end of NLSIP and to 1906 thousand in case of cattle and 3578 thousand in case of buffaloes in the next 15 years;

   (vi) Plan for keeping 34 cattle bulls and 52 buffalo bulls under semen collection by the year-end of NLSIP, and

(vii) Plan for obtaining 34 cattle bulls and 46 buffalo bulls from the genetic improvement programmes for bull replacement during the Project period of NLSIP.

3. **Performance and Pedigree recording and genetic evaluation programmes:** To make available the targeted number of young bulls of mainstream breeds required for replacement, it is proposed to initiate three performance and pedigree recording and genetic evaluation programs one each for HF crossbred, Jersey crossbred, and Murrah crossbred. It is recognized that implementation of a classical progeny testing programme will not be feasible as the age at first calving is high and by the time progeny test results of bulls put to test are available the bulls either would not exist or would be too old to give semen. It is recommended hence to follow a young bull production programme where in young bulls are produced using semen of progeny tested sires and top recorded dams. It is also recognized that genomic information on young bulls will greatly enhance the accuracy of selection of young bulls. Besides, it is equally important to ensure that the bulls put under the test programme are the sons of the very best sires and dams. In this context, it would be prudent to use imported semen of very best progeny tested sires to produce young male calves to be put under test along with local bulls. The minimum recommended standards to be achieved are briefly given below:
    - About 15-20 bulls to be put to test in the first year and raised to 30-40 in the fifth year. These bulls should be produced using very best sires and dams.
    - If an adequate number of young bulls are not available locally, semen doses of young bulls need to be imported.
    - About 100-150 semen doses of very best progeny tested bulls also need to be imported of each breed every year to produce young bulls to be put under test.
    - About 2000 doses of each bull put under test to be distributed in as many herds/villages to ensure at least 70 to 100 complete first lactation records of daughters per bull.
    - In addition, some 1000-1500 doses per bull to be stored for nominated mating till progeny test results of bulls put to test are available.
    - The required infrastructure to carry out test inseminations and recording all production, reproduction and functional traits is to be established.
    - An appropriate software application is to be developed to capture data of all events like identification and registration, AI, pregnancy diagnosis, calving, female calf registration, female calf follow-up for growth, milk recording, body typing, etc.
    - The very best 10 percent of progeny tested bulls and the very best 5-10 percent of recorded cows to be used for producing the next generation of young bulls.
    - About 50 percent of young bulls after their test inseminations could be selected based on their breeding value/genomic breeding value. The semen doses of these bulls will be used in the field for the production of herd replacement.
    - It is assumed that with employing this process, in the long term on average genetic progress of 1 to 1.5 percent per year can be achieved.

4. **Infrastructure for measurement of traits**: The number of municipalities that can carry out some 40,000 inseminations per year each in HF crossbreds, Jersey crossbreds and Murrah crossbreds in the first year and some 80,000 in each breed in the fifth year need to be selected for establishing the infrastructure for performance and pedigree recording. Within each selected municipality all villages/wards and within the selected villages all dairy farmers need to be persuaded to participate in the programme. Once the farmers are selected, their all animals

whether they are HF crossbreds or Jersey crossbreds or Murrah crossbreds need to be included under the performance and pedigree recording. The necessary facilities then need to be set for performance and pedigree recording taking the Livestock Service Section (LSS) of Municipality as a focal point of activity. The necessary facilities and working arrangement need to be established then for recording all production, reproduction, growth and type traits.

5. **Semen production:** As per the broad national targets set for semen production, the semen station of NLBO would need to produce about 1800 thousand doses and maintain about 85 bulls. **T**he semen station at NLBO has the capacity to maintain 37 bulls, it is therefore proposed to build additional bull housing facilities to maintain an additional 48 bulls. It is proposed that two modern bull sheds each to house 24 bulls 12 on either side with adequate space for delivery of feed and fodder by a tractor between two rows of individual bullpens, good ventilation with a high roof, and each bullpen with one part having a hard surface and another part having a soft loafing area with a roof need to be built. The existing semen collection arena is quite spacious. To improve bull management and achieve optimal semen production, it is proposed to renovate the existing semen collection arena with either having soft floor totally or part having a soft surface and the other hard and enclosed by railing having escape gates in either case. The semen processing laboratory is quite spacious with all the required equipment adequate enough to process more than five million doses. Some minor additional equipment whenever required could be provided.

6. **LN and semen distribution**: one of the consistent demand and recommendations from state level interaction workshops is decentralization of LN distribution. (detail approach and plan is elaborated in the action plan. It is proposed to decentralize and modernize LN and semen distribution system with installing 11 LN silos at strategic locations and distributing LN from these silos largely through vehicle mounted LN tankers.

7. **AI Delivery**: Assuming that in the future all inseminators together would carry out about 600 inseminations per year, to do some 1800 thousand inseminations the country would need about 3000 inseminators by 2023-24. It is proposed to add 1900 new inseminators to the current number of 1100 inseminators. To select the districts for expansion, the districts first could be classified based on the number of breedable animals and the coverage of AI. The districts that have a high number of breedable animals and medium AI coverage could be selected first for AI expansion efforts and then progressively those with high breedable population but low AI coverage could be selected. A priority list of districts for progressively increasing AI coverage is given in the action plan. To translate this into program, we suggest to decide district and municipalities from respective DPs for NLSIP and from NLBO/LBO and respective Directorate of the States for other areas. This is critical for all activities – training inseminators, logistics, LN supply, etc.

   The future engagement of technicians can be done through the existing cooperatives and producers organisations. NLBO, LBO, and VH&LSSC can organise new AI technicians training programmes and issue a license for AI after proper skill test. Refresher training programmes could be organised at VH&LSSC. Financial support should be provided from State and Federal governments for the entire AI program in all the municipalities, keeping cooperatives and producers' organisations in the semen and liquid nitrogen distribution network. AI services should be incentivized by local governments. A system for regular monitoring and assessment of inseminators' technical skills should be developed and implemented.

8. **Indigenous breed development**: There are some important indigenous cattle (Lulu, Achhami, Phahadi, Khaila, Terai and yaks) and buffalo breeds (Lime, Parkote, and Gaddi). Though they may not be that important for meeting the consumer demand of milk like the three mainstream breeds (HF cross, Jersey crossbred, and Murrah crosses) they provide needed organic manure and draught power for agriculture production, animal nutrition for households through milk, and supplementary income through bones and hides besides buffaloes proving meat. The indigenous breeds are resistant to diseases, have the ability to survive in harsh environmental conditions and on low nutrition diet, and are important to provide sustainable livelihood to a large number of farmers in marginal areas. The population of Lulu cattle, lime buffaloes and Yak has been declining. There is a need to develop practical in situ breed conservation and development programmes based on two-tier or three-tier breeding structure initially through natural service and gradually changing over to AI involving research institutions, local NGOs and local governments. The challenge will be to define right breeding goals – traits to be included in breeding goals and their weights - and develop the right infrastructure for measurement of traits included in breeding goal as some of the traits of important in local breeds like resistance to diseases, surviving in harsh climate, ability to perform under low nutrition diet are difficult to measures in the field. The government must make budgetary provision to support such local breed development efforts and sustain them for a long period of time.

9. **Implementation arrangement**: For smooth implementations of all breeding activities, it is proposed to make NLBO as the lead implementing agency and set up a Livestock Genetics Improvement Unit (LGIU) with four team members one responsible for implementation of Performance and Pedigree Recording and Genetic Evaluation, second responsible for semen production, procurement, import, and distribution, third responsible for AI expansion and monitoring, and the fourth responsible for data processing. It is also proposed to constitute a management committee referred to as Livestock Genetic Improvement Management Committee (LGIMC) chaired by the Project Director, NLSIP with Chief Livestock Development Officer, NLBO, a specialist from the National Livestock Resource Management and Promotion Office, a representative from NARS, a representative of VH&LSSCs, a representative of municipalities, and the team leader of LGIU as members. The team leader of LGIU can act as the member convener. The Livestock Genetic Improvement Management Committee (LGIMC) can be made jointly responsible for the implementation of all breeding projects approved under NLSIP. Roles and responsibility of all other personnel identified in Chapter 7 be circulated for role clarity of all.

8 Human Resources and capacity building: There will be about 30 personnel from DLS (VH&LSSCs, NLBO, and LBO), PMU and DLSU, NARC, National Livestock Resource Management and Promotion Office (NLRM&PO), and private sector to be trained and developed as a core team of experts for implementing and sustaining the breeding programmes. This core team needs to be developed with organising appropriate training programme within and outside the country. The key senior officers of PMU and DLS should also be exposed to best practices in animal breeding through short overseas exposure visits.

Apart from the team of core officers, there will be some 300 AI technicians, 300 milk recorders and 50 milk analyser cum data processing assistance to be engaged and trained in the activities related to performance and pedigree recording and genetic evaluation. Specialised training programmes need to be developed for each category of personnel and detailed training manuals need to be prepared which can be used for training and later for reference.

9. **Policy and legal framework**: Animal identification and registration is a prerequisite for implementing performance recording and genetic evaluation. A nation-wide system of uniquely identifying dairy animals needs to be evolved. It is recommended to use 15-digit ISO code - 3 digit country code and 12 digit ID code within the country - for identifying an animal. Within the country, the country code is not printed on the ear tag i.e. ear tag number is usually of 12 digits. It is advisable not to use any breed, region code in the animal number. The number should be just a serial number within the country. A check digit should be added i.e 11 digits as a serial number with the last digit as a check digit derived from first 11 digits.

   It is anticipated that a proper breeding policy document would be in place and enforced through some provisions in the existing act or enacting a new law for this purpose. The existing provisions in the Animal Health and Livestock Services Act, 2055 (1999) could be appropriately amended to enforce regulation with regard to identification and registration animals, development of local breeds and mainstream breeds, castration of unwanted males, etc.

   Developing an appropriate information management system is critical to the successful implementation of all breeding programmes. In fact without a computer application breeding programmes cannot be implemented. It is important that all the information needs of breeding programmes are incorporated in the common application developed for NLSIP.

Recommendations for Goat Genetic Improvement

Goat farming has emerged as one of the important enterprises for both commercial meat production, breeding stock production and income generation in poverty reduction and livelihood improvement programs targeted to smallholders. These production farms face persistent gap in supply of replacement stocks of predictable productivity, thus, the productivity of goat has remained stagnant or even declined due to haphazard mating or even negative selection (superior bucks are castrated). To address this gap, the genetic improvement program for goat revolves around establishment of and operation of open nucleus herds, multiplication herds of selected breeding stocks produced in open nucleus breeder herd and supply of replacement breeding stocks to production herds from multiplier herds/breeder herds.

We propose that the country should expand in a more scientific way the performance recording system in goats at the cluster/community level initiated by Heifer International Nepal, KUBK and AFSP. The missing part in these past initiatives is generation of data that can be subjected to analysis of performance and evaluation based on genetic merits of individual animal, which NLSIP will innovate and demonstrate through computer based data management and analysis at the cluster level. It is strongly recommended that all promising meat type breeds be promoted and commercialized for achieving the sufficiency in meat. Similarly, in selected areas, dairy goat breeds such as Saanen and others be promoted.

The key specific recommendations are:

1. Breeds to promote in the initial years
   a. Terai and mid hills : Boer, Sirohi, Terai and Khari
   b. High Mountain: Sinhal and *Chyangra*

c. Fur: *Chyangra and research o*n Angora goat
d. Dairy goat breed: Saanen: Evaluate and make recommendation based on whatever data are available in ARS Bandipur.

2. Approach to follow is establishment of resource centers in clusters to maintain true type breeds (discussed in detail in the strategy and action plan)

3. Government goat farms have maintained different breeds and taken germplasm for multiplication and dissemination in the outreach sites. They also produce breeding stocks and sale to farmers. We propose to transform these government/NARC farms as open nucleus breeding herds of elite stocks through partnership with private sector. Maintain best performing animals in these elite herds in a open nucleus concept based on PPRS (the best elite animals be brought to farm and maintain a critical mass of elite animal of the breed in question). This will apply to all breeds proposed in the action in details. The only additional activities to for this transformation are:
   - Adoption of PPRS and evaluation system
   - Provisions for procurement of best animals from farmers to the farm

   For Sinhal and Chyangra, DLS/NLSIP need to work with respective farmer groups and associations in the model described in action plan (with 2,000 breedable does)

4. Adopt breed specific selection program adopting performance recording system in clusters first. Once robust LIMS is in operation, data for selection within a breed could be pooled at the national level. Breed specific selection program are:
   - Crossbreeding program with Boer breed with PPRS system in place for selection program – focus will be in selected clusters of Terai and mid hill physiographic regions.
   - Crossbreeding program with Sirohi breed with PPRS system for selection program - upgrading plan using bucks of Sirohi breed in mid-and far western states of the country.
   - Intra-breed genetic improvement program in Khari with PPRS for selection in mid-hill districts
   - Selection program for Terai (native) goats using bucks of Native breed in eastern Terai foot hills.
   - Promote dairy breeds (Saanen and its crossbreeding program) in certain pockets for niche value products
   - Selection program for Sinhal in high Mountain areas.
   - Selection program for Chyangra incorporating traits for “Pashmina production).

For each breed two tiers of herd be maintained for gene multiplication and dissemination purpose.

- Goat Breeder herds: For each breed specified in action plan (Boer, Sirohi, Terai, Khari, Sinhal, Chyangra) a breeder herd of about 2,000 does be established by registering female lines of government goat farms, selected commercial farms (larger farms where mating is manageable as per breeding plan) and outreach sites of the government/NARC goat farms combined. NLSIP will consider first for swift multiplication of Boer breed.
- Multiplication Herds: establish multiplication herds in the community for the same breed that has been promoted in nucleus herd

- The replacement stocks be supplied to production herds from culled sub set of breeder herds and the stocks production in the multiplier herds

5. Import 120 pure Boer bucks and 6,000 doses of Boer semen to implement cross breeding program using Boer breed in two clusters.
6. For the rest of the breeds, breeding bucks be selected from within the available base population in the country (Government farms, community breeding centers and Commercial farms). If absolutely needed, Sirohi bucks in needed numbers be imported from India (once cluster level planning on PPRS is worked out next year).

   Scope of artificial insemination in goats is limited. Goat semen utilization would be confined to breeder herds, multiplication herds and some interested commercial farms. AI program in goats would not be a routine extension service as it will not be widely accepted and popularized the way it is in dairy animals. Recognizing this, goat semen production and import would be linked with the demand from Nucleus herd and multiplier herds. Since, goat semen production is in initial trial phase and the outcomes/impacts of inseminations is yet to be evaluated, detail planning of AI programme in goats would be impractical at the moment. Moreover, semen doses that were locally produced and/or imported are also not utilized, therefore, future predictions of semen doses of goat semen has become impractical at present. Goat semen production of all the breeds listed above be continued at status quo using the semen production laboratory facilities available in NLBO Pokhra and/or to be created in Gaught, Banke.

7. NLSIP will develop a computer based data management system for PPRS implementation at the cluster level. A single software can be used for different clusters.
8. Animal identification system be executed adopting the same principles recommended for dairy animals.

   Policy and Legal framework:

9. Amendment and enforcement of existing Acts (Specifically Animal Health and Livestock Service Act and its effective enactment ensured to address with issues related genetic improvement – for example, mandatory castration of breeding males not certified as breeding stock and similar breeding activities including rearing of kids to certain age for evaluation.
10. As per the intent of the Agriculture Development Strategy there is need to facilitate to create and strengthen POs and partner with them in program implementation **(**ADS terminology for POs is Value Chain Development Alliances (VCDA)**)** – These societies be registered with respective local municipalities and inventory maintained at VHLSSC. VHLSSC will be the key agency to provide breeding specific support in conjunction with LBOs and NLBO.
11. The same unit i.e. "Livestock Genetic Improvement Unit" of the NLBO and other institutional structures will be responsible for execution goat breed improvement program. The technical task group may include member from location specific government goat farm.
12. NLSIP should give priority for development of Human Resource specialized in goat (Breeding, Feeding, Health, Business Management) by providing specialized training, higher education and exposure visits to service providers including paravets:
13. Specialized goat training centers at NARC/DLS offering Goat Husbandry/Goat Breeding/Goat Nutrition/Goat Health.
14. As stated earlier development of *Chyangra* resource center would be in PPP model (for increasing quality breeding animals from private sectors) – NLSIP will import required bucks (about 60) once participatory planning is carried out with the community in Mustang.

Annexes

Annex I : Data elements to be recorded for different events

	Event	Data elements
1	Registration of owner	Owner's ID, House Hold ID, Owner name, Owner's father name, Gender, date of birth Location: address/village/ward/municipality/district/province, Longitude, Latitude Mobile Number, Landline number If member of dairy society, his registration number
2	Registration of Animal	Animal ID, Sex, Species, Breed, Date of Birth or Age Sire ID, Sire's sire ID, Dam ID, Dam's sire ID Number of calving, last calving date Pregnancy status, Milking status
3	Animal Movement	Animal ID, Movement type: sold, purchased, died, culled Purchased from details Sold to details
4	Artificial insemination	Animal ID Date of insemination Semen/Bull ID, Semen batch number, AI type: Routine/Nominated
5	Pregnancy diagnosis	Animal ID Date of PD Result of PD
6	Calving	Animal ID Date of calving Calving type: Abortion, Single female, Single male, Still birth, Twin Ease of calving: Normal, Slight pull, Heavy pull, Dystokia, Sex of calf born, ear tag number of new calf (for female) Birth weight
7	Milk Recording	Animal ID Recording : Morning, Afternoon, Evening Milk Volume/Kg. Sample bottle number, Sample box number
8	Growth monitoring	Animal ID Date of measurement Length in inches, Girth in inches, Weight (if measured)
9	Body typing	Trait: Score: Traits: Stature, Heart girth, Body length, Body depth, Angularity; Rump angle, Rump width, Rear legs set, Rear legs rear view, Foot angle, Fore udder attachment, Rear udder height, Central ligament, Udder depth, Front teat placement, Teat length, Rear teat placement, Rear udder width, Teat thickness, and Body condition score

Annex II Standard Operating Procedures for Performance and Pedigree Recording

Introduction

This document on Standard Operating Procedure (SOP) for Performance and Pedigree Recording (PPR) provides clear guidelines on how to measure a particular trait, what tools would be needed to measure a trait, when and where a particular task is to be done, and what support would be required to complete the task. The SOP is for the field, supervisory and managerial staff who would be implementing PPR for genetic improvement programmes planned under NLSIP. This can be used as a reference document for carrying out all activities under performance and pedigree recording. The document begins with animal identification, which is a prerequisite for all other activities, and then provides guidelines for other traits one by one.

Animal identification

Before any activity is carried out on an animal, it should be identified with applying an ear tag on one of its ears. All female animals that are inseminated with test doses, the female animals that are milk recorded, all daughters that are born under the project, and all male calves that are born out of nominated mating should be identified. A polyurethane laser printed ear tags having a unique number and a bar code should be used. A 12 digit numbering system with the last digit as check digit should be followed. To maintain the uniqueness of number across the country, NLSIP can generate the required numbers and provide them to ear tag suppliers. The ear tag should be applied inside the ear of the animal, in the center of the ear lobe with the female part of the tag inside the ear. If the ear tag falls off, a new ear tag shall be applied and the information should be updated in the computer system.

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Right place to apply ear tag

Test inseminations

Minimum 2000 test inseminations should be carried out per bull put to test. The core project management team located at NLBO shall prepare a month wise, municipality wise and bull wise semen distribution schedule ensuring that semen doses of each bull put to test are used in the maximum number of municipalities every month for all months. The AI technician in the project area shall collect the required test doses from the LSS of the municipality and use only the test doses supplied by NLBO for the month. The AI technician shall follow the Standard Operating Procedure laid down for carrying out AI (See SOP for AI). If the animal to be inseminated is not ear-tagged, the AI technician shall apply an ear tag and register the animal filling the animal registration format after carrying out insemination. After AI he shall also fil up the AI format. After 60-90 days, the animal should be examined for pregnancy diagnosis and the results should be reported in the PD format. The animal then should be followed up for calving.

Daughters' registration

Once the animal calves, the AI technician and the concern supervisor visit the farmer's place within 45 days and verify the animal's and its dam details and on the satisfaction of the correctness of the information, the AI technician shall ear tag the female calf born and report calving details and new calf born information in the calving format. This way new female calf born is registered automatically and its pedigree details are updated. After registration of new calf born, the AI technician shall also measure the length and heart girth of the new female calf and report the data in the growth monitoring format. Body length is measured between the point of shoulder and the pin bone in inches. The heart Girth is measures as circumference of the thorax at the point of elbow.The length and heart girth measurements are used for estimating body weight using the following formula:

Body weight (Kgs) = (Hearth Girth (inches))^2 * Body Length (inches)/660

Follow up of daughters

After the birth of the calf, the follow up of the female calf involves visiting the farmer's place every six month by the milk recorder. During this six-monthly visit, he shall carry out body measurements to assess growth, deworming, and vaccination. Such six monthly visits shall continue till the animal calves, which is followed up with monthly milk recording. During his visit, he shall report death and sale and also apply a new tag in case the old tag has fallen.

Body measurements: The body measurement shall be done by the AI technician and subsequent six-monthly body measurement shall be done by the milk recorder. Body weights are calculated based on the length and heart girth**.** Body length is measured between the point of shoulder and the pin bone in inches. The heart Girth is measures as circumference of the thorax at the point of elbow. The length and heart girth measurements are used for estimating body weight using the following formula:

Body weight (Kgs) = (Hearth Girth (inches))^2 * Body Length (inches)/660

Based on the estimates of body weights the participating farmers are advised on rearing of their calves.

Milk recording

The assignment of the number of animals to a milk recorder depends on the average number of animals per farmer that he has to record and the spread of participating households A few general guidelines on milk recording include the following:

i. First milk recording shall be done on or after 5 days of calving and not later than 25 days of calving.
ii. Milk recording of the animal is to be done once a month morning and evening and also in afternoon if three times milkings is practiced.
iii. Milk recording is to be done on a fixed day of the month – plus or minus 5 days- at the farmer's door step.

iv. The measurement of milk yields could be done either with a calibrated plastic jar or with a weighing scale or an electronic weighing machine.
v. If weaning is not practiced then on the day of recording the farmer could be persuaded not suckle on the day of recording.
vi. Milk recording will not be done if milk has dropped 50% of the previous moth's recording. In such cases reason of not milk recording should be recorded and milk recording should be attempted after 5 days.
vii. If the animal gives milk only one time, then only one milk recording is recorded and other is kept blank.
viii. On each monthly recoding a milk sample should be taken in sample bottle preferably at the time of morning milking for milk component analysis. Milk samples of 2-3 days are to be sent together in a box or a beg to the designated place where milk component analyser is installed.
ix. The milk recorder should record milk yield details in the milk recording format and also record the same on the milk recording card given to farmer for each animal.
x. Standard lactation yield of the recorded animal should be estimated using the Test Interval Method (A4) described at section 2.1.5.1 of the International Agreement of Recording Practices published by International Committee for Animal Recording (ICAR).

The milk yield measurement could be done either by a calibrated plastic jar, a weighing scale or an electronic weighing machine. A few points that should be kept in mind while using either of these devices are given below:

- While measuring milk yields by a calibrated plastic jar one has to discount for the froth that is generated at the top of the jar while pouring milk.
- While using a weighing scale one has to make sure that initially the dial is at zero.
- While using electronic weighing machine one must make empty vessel weight to zero.




Weighing Scales

Electronic Weighing Machine

Supervision of milk recordings

The number of supervisors to be engaged depends on the number of villages a supervisor can supervise and the distance between villages. Usually, one supervisor could be appointed per municipality.

The supervisor's job shall check all calving, at least 30 percent of milk recording, and 30 percent of body measurements. For checking milk recording the supervisor shall conduct surprise checking my visiting the place of scheduled milk recording by the milk recorder and check procedure of milk recording, equipment used and the data recording. The supervisor shall also visit randomly selected farmers whose animals are under recording and measure the quantity of milk produced and compare with the last recording done by the milk recorder.

Type classification

The traits that defined body characteristics are referred to as type traits and the classification of animals based on type traits is referred to as type classification. While animals are selected for milk production, weightage should also be given to type traits to sustain the high level of production for a long time period. Negligence on type traits leads to locomotion problems, mastitis, infertility, dystocia, low feed conversion efficiency, etc. and consequently affect the life time production of the animal. The type traits that are functionally important and that are scored mostly on measurements are divided into four groups. They are: (i) Dairy strength: Stature, Heart girth, Body length, Body depth, and Angularity; (ii) Rump: Rump angle, and Rump width; (iii) Feet and legs: Rear legs set, Rear legs rear view, and Foot angle; (iv) Udder: Fore udder attachment, Rear udder height, Central ligament, Udder depth, Rear udder width, Front teat placement, Rear teat placement, Teat length, and Teat thickness. Standards for each trait within a breed need to be evolved and biological ranges could be scored into 1-9 scale. A definition and a short description of these traits are provided here. Figures in brackets indicate scores.

1. **Stature**: The length between top of the spine between hips and the ground is defined as stature. It is measured with a measuring tape. Within each breed on 1-9 point scale animals could grouped as: Tall (1), Intermediate (5) and Short (9).

2. **Heart Girth**: The circumference of thorax at the point of elbow is defined as Heart Girth. It is measured with a measuring tape. Within each breed on a nine point scale animals could be grouped as: Narrow (1), Intermediate (5), and Wide (9).

3. **Body Length**: The length between the point of shoulder and the pin bone is defined as body length. Animals could be short (1), Intermidiate (5), or Long (9).

4 **Body Depth:** It is measured as distance between the top of spine and the bottom of barrel at the last rib. It is half of body girth at the deepest point of barrel. Body depth could be shallow (1), Intermediate (5), or Deep (9).

4. **Angularity**: The angle formed by two imaginary line one perpendicular to the floor and other in the direction of last rib is defined as angularity. Non-angular (1), Intermediate (5), and Angular (9).

5. Rump Angle: It is an angle of the rump; measured as the distance between two parallel imaginary lines drawn one from the point of hip and another from the upper most point of pin. If the point of pin bone is below the point of hip bone, the measure is positive and if it is above the point of hip bone it is negative. Animals could be classified as high (1), Intermidiate (5) or Low (9).

6. Rump Width: It is defined as the length between the most posterior point of pin bones. Animals could have narrow width (1) or Intermediate (5) or Wide (9) Rump Width.

7. Rear Leg Set: It is a subjective evaluation scored on the basis of an imaginary line passing foot through hock. It could be straight (1) or Intermediate (5) or Curved (9).

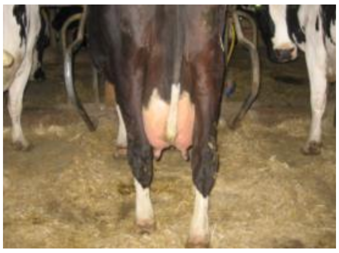
Straight

Intermediat

Curved

Rear Legs View: It is a subjective assessment of the view of rear feet from the rear. The reared feet may be viewed as hocked-in (1), Intermediate (5) or Straight (9).

Hocked-in



Intermediat

Straight

10 **Foot Angle:** It is a subjective assessment of the angle at the front of the rear hoof measured from the floor to the hairline at the right hoof. It could vary from Low (1), Intermediate (5) to Steep(9).

Low

Intermediate

Steep

11. **Fore Udder Attachment:** It is a subjective assessment of the fore udder attachment to the abdominal wall. It may be week (1) to Intermediate (5) to Strong**.**

12. **Rear Udder Height:** It is measured as the length between the bottom of the vulva and the rear point of attachment of the mammary gland. Grouped into Low (1), Intermediate (5) and High (9).

13. **Central Ligament**: It is the depth of cleft, measured at the base of the rear udder. It may vary from weak (1) to Intermediate to Strong (9).

14. **Udder Depth**: The distance between the lowest part of the bottom of udder to the imaginary line parallel to the floor crossing through the hock. They could be Deep (1), Intermediate (5) or Shallow (9).

15. **Udder Width**: It is defined as width at the point where the mammary glands get attached to the body at the rear.

16. **Front Teat Placement**: It is the view of the position of the front teats from the centre of quarter of the udder as viewed from the rear. It may be Wide (1), Intermediate, or Close (9).

Wide

Intermediate

Close

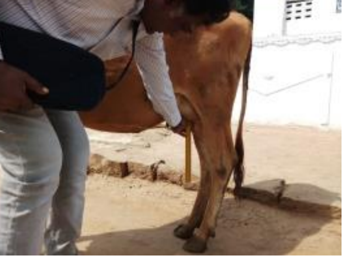
17. **Rear Teat Placement**: It is the view of the position of the rear teats from the centre of quarter of the udder viewed from the rear. It may be wide (1), Intermediate (5) or Close (9).

Intermediate

Close

Close

8. **Teat length**: The length of the left front teat is taken as the length of the teat. Classified as short (1), Intermediate (5) and Long (9).



20. **Teat Thickness**: It is the circumference of the left front teat at the middle.

Annex III Standard Operating Procedures for Frozen Semen Production

Preamble

The Department of Livestock Services (DLS) has prepared a document on the Standard Operating Procedures (SoP) to be followed for production of frozen semen and is currently being used. This document is a modified version of the existing SoP incorporating the suggestions of the consultants. All suggested modifications should be examined by experts before their adoptions.

Introduction

Artificial Insemination with frozen semen has been proved to be the best tool worldwide for genetic improvement through dissemination of superior germplasm. This objective can be achieved only if the frozen semen used in AI program conforms to the quality standards. For the production of quality semen, it is important that the bulls used in AI program satisfy quality norms, are disease-free and semen is produced and processed in accordance with the standard protocols. The minimum protocols required for the production of quality semen are covered in this manual. Failure to observe these guidelines could lead to production of poor quality semen making it unfit for its use for artificial insemination.

CHAPTER I

Selection of bulls for semen production

The bull for semen production should first be selected on its genetic merit followed by its physical examination and sexual behaviour.

3.1 Genetic merit

The bulls required for semen production must come from the progeny testing programmes following the minimum standard and SoP approved by DLS. In case, such bulls are not available or a PT programme for certain breeds is not being run, the bulls for semen production may be procured based on dam's standard lactation yield as given in Table 1. Lactation yields should be arrived at by recording the animal at monthly interval continuously for 11 times or until the animal becomes dry but not less than 8 recordings. Standard lactation yield of animal is to be calculated using the Test Interval Method (A4) described at Section 2.1.5.1 of the International Agreement of Recording Practices published by International Committee for Animal Recording (ICAR). Before procurement of bull its parentage should be verified by a DNA finger printing.

Table 1. Minimum standard of dam's yield for selection of bulls

Breed	Minimum standard of Dam's lactation yield			Remarks
	First	Best	Fat %	
Pure Holstein Friesian	4500	5700	3.5	
Pure Jersey	3000	3700	4.5	
HF Crossbred	4000	5000	4.0	
Jersey Crossbred	3000	3500	4.5	

Pure Murrah	2400	3000	7.0	
Murrah Crossbred	2200	2700	7.0	
Other indigenous cattle breeds				As prescribed by DLS time to time
Other indigenous buffalo breeds				As prescribed by DLS time to time

3.2 Physical examination

Before procuring new bull calves/bulls for the semen station, a thorough physical and andrological examination should be conducted by an experienced veterinarian with respect to breed characteristics, general health and suitability as a breeding bull. The following characteristics should be examined:

A. Physical characteristics:

- Conformity to breed characteristics
- Gentle gait, equally distributed limbs.
- No deformities in hooves.
- Both testicles should be descended.
- Scrotal circumference should be 30 cm at 18 months age.
- Animal should weigh 250 Kgs. at 15th month.
- No umbilical hernia.
- No pendulous sheath.
- No warts.
- No bad vices like masturbation.

B Bull's sexual behaviour:

- Sexual arousal.
- Courtship: Guarding, chin resting, sniffing, licking, nuzzling, frontal contact etc.
- Erection of penis and penile protrusion.
- Mounting.
- Seeking for vulva (location)
- Ejaculatory thrust.
- Ejaculation.
- Dismounting.

3.3 Karyotying and testing for Genetic disorders/ diseases

All bulls should be karyotyped to rule out any chromosomal defects. Besides, certain breed specific Genetic disorders such as Factor XI deficiency syndrome, Bovine Leukocyte Adhesion Deficiency (BLAD), Citrullinemia, and Deficiency of Uridine Monophosphate Synthase (DUMPS) should be done for HF and HF crossbred bulls and in Jersey and their crosses.

3.4 Identification of bull

Any bull entering the quarantine or the main semen station should be identified by applying an ear tag having a unique identification number. In case the ear tag falls, a new ear tag should be applied and all information of the bull stored with previous ID should be transferred to new ID. In case the bull is transferred or sold to other semen station, the ear tag should not be changed.

3.5 Quarantine

Any new bull calf or adult bull to be inducted in the semen station should go through the quarantine procedures laid down by DLS. A minimum period of 60 days at quarantine station is mandatory. Only after following the prescribed health protocol for the quarantine station, the bull should be admitted to the semen station. Manpower deployed and all equipment used in handling, feeding, watering and cleaning the new bulls should not be shared with the main herd. Each new animal in quarantine station should be tested against major contagious diseases before its entry to rearing/ main station namely TB, JD, Brucellosis, Campylobacteriosis, Trichomonosis Infectious Bovine Rhinotracheitis and Bovine Viral Diarrhoea. All tests shall be done by an accredited agency. During the quarantine period, the bulls should be vaccinated against FMD, HS, BQ, and Theileriosis. Once the quarantine period is over, all bulls should be introduced to the young bull rearing station or to the Semen Station depending upon the age of bulls.

CHAPTER : II

4.0 Standard operating procedures for the management of bulls

The Standard Operating Procedures (SOP) provides general guidelines for all the activities that are taking place in a frozen semen production station.

4.1 Housing

Bulls have to live 24 Hours and 365 days in the housing facilities provided. The comfort that animal gets in the housing facility determines the quality and quantity of semen produced by the bull.

Housing and temperature control

- The sheds should be in East–West direction to avoid direct sunlight on bulls. There are reports of testicular degeneration due to intense sunlight on testis / scrotum.
- In case the sheds are already in north–South direction, measures should be taken to provide shade to bulls to protect from direct sunlight. The sheds should be airy and allow breeze.
- Trees to protect from hot air during summer should surround the sheds. There should be top ventilation to allow escape of hot air.
- In the states where the climate is hot most of the part of the year, the sheds should have minimum walls and steel pipe railing should be used for better ventilation. There should be provision of water foggers and fans for use during the summer particularly for exotic breeds and buffalo bulls.
- The fans and water foggers should be operated alternately for about 4 – 5 hours / day during summer time.
- During summer, it is desirable to wash the buffalo bulls twice a day.
- It is recommended to groom the cattle bulls with coir / nylon brush every day to keep the skin in shining and glowing condition.
- Single bullpens having loafing area are suitable and ideal for breeding bulls. The bulls should be kept free.
- Shed should be cleaned thoroughly every day.
- The bullpens should have feeding manger and water trough. Each bull should have adequate covered area.
- In places where the climate is very cool most of the year, the walls are recommended. However attention should be given to ensure adequate ventilation and avoiding stale air in the sheds.

- In places where the individual bull housing is not practiced, adequate bedding should be provided.

Flooring

- Each bull should have adequate loafing area (minimum 10 M^2).
- The flooring of covered area should be non-slippery cement concrete with adequate grooves. The flooring of the loafing area should be preferably with natural soil.
- In case of heavy rainfall areas, the flooring can have sub soil drainage system to avoid slush.
- To avoid excessive slush in monsoon, there should be drain to take away rainwater from roof.
- The housing should be designed in such a manner that the personnel working are safe.

If possible the loafing area and covered area should be separated with a gate so that persons can

4.2 Feeding of Bulls

Daily nutrient requirements of growing and mature bulls *

Body wt	gain/day	DM/day	C.P. (g)	TDN (kg)	Ca (g)	P (g)	Vit. A	Vit D3	Vit. E
(kg)	(g)	(kg)					(1000 IU)	(1000 IU)	(IU)
Growing bulls									
100	750	2.8	429	2.09	11	8	10	2	150
150	750	4.3	506	2.97	15	11	12	2.4	150
200	750	5.7	583	3.74	18	14	13	2.6	150
250	750	7	671	4.40	21	16	15	3	150
300	750	8.2	748	5.06	23	17	20	4	150
350	750	9.3	836	5.72	24	18	20	4	150
400	700	10.2	902	6.27	25	19	25	5	150
450	600	10.4	963	6.38	26	20	25	5	150
500	400	10	974	6.16	26	20	25	5	150
550	250	10	930	6.16	25	19	25	5	150
600	100	9.8	880	6.05	24	18	30	6	150
Maintenance of mature breeding bulls								0	
500	-	8.3	704	5.06	20	15	30	6	150
600	-	9.6	808.5	5.94	22	17	30	6	150
700	-	10.9	913	6.71	25	19	30	6	150

Daily Ration for bulls

Body wt.		Calf starter	C.F.	B.P.F.	Hay	Green Fodder
(kg)		(kg)	(kg)	(kg)	(kg)	(kg)
Growing bulls						
100		2	-	-	0.5	6-8
150		-	-	2	0	8-10
200		-	-	2	0.5	15
300		-		2	1	ad lib.
400	a)	-		2	3	ad lib.
	b)	-	2.5	-	3	ad lib.
500	a)	-	-	2.5	2-4	ad lib.
	b)	-	3	-	2-4	ad lib.
600	a)	-	-	2.5	2-4	ad lib.
	b)	-	3	-	2-4	ad lib.
Mature breeding bulls						
500	a)	-	2.5	-	2-4	ad lib.

	b)	-	-	2	2-4	ad lib.
600		-------------------------------do-----------------				
700		-------------------------------do-----------------				

* Modified based on Ranjhan, S.K (1980). Animal nutrition & feeding practices in India,

Mineral mixture should be supplemented as follows:

50 g mineral mixture for bulls up to 200 kg body weight
70 g mineral mixture for bulls between 200 to 350 kg body weight.
100 g mineral mixture for bulls above 350 kg body weight

Fresh water should be made available 24 hrs.

Green fodder requirement of 10 mature bulls would be approx. 125 MT per year, which can be grown in 1 hectare of land by intensive farming.

4.3. Grooming of bulls

- All the bulls should be groomed at least once a day, this helps maintain good health of the bulls and keep their coats clean.
- Washing of the bulls is desirable.
- Grooming increases peripheral blood circulation and increases semen production.
- Grooming of bulls every day, minimum 20 minutes per bull is essential for production of good quality of semen

4.4 Exercise

All the bulls should get exercise for at least 20 minutes every day. During the exercise, it would be possible to observe the gait and note any lameness / foot problems.

4.5. Deworming

Deworming is done once in 6 months or as required. Regular faecal examination will determine the frequency of deworming.

4,6. Hoof trimming

Hooves of bulls should be examined every fortnight and trimmed every three months or as needed. Foot bath should be given to all the breeding bulls with 4% formalin or 4% copper sulphate solution

4.7. Watering

Adequate drinking water should be provided to bulls 24 hours a day.

4.8. Prepucial hair clipping

Prepucial hair clipping of adult bulls should be carried out **once in a month**. The length of the hair at the pr eputial orifice should be cut leaving at about **2 cm** to prevent bacterial load in the preputial orifice.

4.9. Body weight

The following should be the body weight at the time of semen collection and breeding:

Jersey 275 kgs. body weight and 15 month age.
Holstein 300 kgs body weight and 15 month age.
Murrah 275 kgs. body weight and 30 month age

All bulls should be weighed every month.

4.10. Culling

To minimize expenditure on feed and fodder cull:

- The bulls with poor libido
- Poor serving ability
- Poor semen quality
- Poor freezability
- Old age over 9 years

4.11. Isolation

- Sick animals should be segregated from the normal stock in isolation shed
- Separate feeding and watering should be provided.

4.12. Preventive measures

The following vaccinations have to be carried out against contagious diseases:

- Foot and Mouth disease
- Black quarter disease
- *Haemorrhagic septicaemia*

4.13. Management of major diseases

(A) FOOT AND MOUTH DISEASE MANAGEMENT

	Animal	Isolate diseased animals till recovery, do not cull.
	Semen	Semen from FMD infected Bulls: - Destroy semen collected during one month before onset of outbreak. Do not collect semen from bulls during the outbreak and three months after the last case of FMD recovered in the farm. Infected animals must be given 90 days rest.
Action during FMD outbreak		Semen from healthy bulls maintained in FMD infected farm: Destroy semen collected during one month before onset of outbreak. Do not collect semen from bulls during the outbreak and one month after the last case of FMD recovers in the farm.

		Semen collected during other than the above mentioned periods, could be used after three months if no new case of FMD develops after last FMD case recovery in the farm.
Quarantine		In Quarantine period
Vaccination	Oil Vaccine	Vaccination – as per manufacture's recommendations

(B) **SCREENING AGAINST MAJOR CONTAGIOUS DISEASES:**

All animals are tested against the major contagious diseases as prescribed schedule as follows:

B1. TUBERCULOSIS

Screening Test details	Name	Delayed Hypersensitivity Single Intra-dermal test
	Reagent	Bovine Tuberculin PPD
	Testing at	Where animals are housed
	Positive result criteria	As per OIE norms **Negative:** Increase in skin thickness less than 2 mm & without clinical signs viz. exudation, necrosis, pain, inflammation of the lymphatic duct of that region or the lymph node, 72 hours post-inoculation. **Inconclusive:** Increase in skin thickness more than 2 mm & less than 4 mm, absence of above clinical signs, 72 hours post-inoculation. **Positive:** Increase in skin thickness 4 mm or more, or presence of clinical signs viz. exudation, necrosis, pain, and inflammation of the lymphatic duct of that region or the lymph node, 72 hours post-inoculation.
Eligible animals		All animals above 6 weeks of age
Frequency of testing	Positive herd	Minimum 60 days after culling of last positive animal
	Negative herd	Annual test is minimum, Six months (+1 week) after last whole herd negative testing, desirable
	Animal	Cull
Action on finding a positive animal	Semen	Destroy semen doses since last negative test.
Tuberculosis free herd (OIE)		Herd found negative on two consecutive tuberculin tests at an interval of 6 months, the first being performed 6 months after the slaughter of last affected animal
Quarantine	Duration of quarantine	Minimum 90 days
	Test schedule	Two tuberculin tests, minimum interval of 60 days between tests.

B2 BRUCELLOSIS

Screening Test Details	Name	RBPT
	Sample	Serum

	Reagents From	
	Testing at	RVL, CVL
Eligible animals		All above one year
Frequency of testing	Positive herd	30 to 60 days after culling of last positive animal
	Negative herd	Exactly one year (+1 week) after last whole herd negative testing
	Negative herd (Optional)	Where the disease has been maintaining a very low profile (less that 1% positive) quarterly or six monthly samples could be collected to minimize losses.
Action on finding a positive animal	Animal	Cull after castration.
	Semen	Destroy the collections since last negative test.
Brucellosis free herd (OIE)		Herd found negative on two consecutive annual tests
	Duration of quarantine	Minimum 30 days

B3. BOVINE GENITAL CAMPYLOBACTERIOSIS

Screening test details	Name	Bacterial isolation and identification
	Sample	Preputial washing, semen
	Testing at	RVL, CVL
Eligible animals		All male animals
Prevention		Annual sheath lavage
Frequency of testing	Positive Herd	30 days after culling of positive animal
	Negative Herd	Exactly one year (+ 1 week) after last whole herd testing
	Animal	Treat the animals
Action on finding a positive bull	Semen	Destroy semen doses since last negative test
	Duration of quarantine	Minimum 30 days
Quarantine	Test Schedule	One test if age is less than 6 months, else 3 consecutive tests at weekly intervals

B4. BOVINE TRICHOMONIASIS

Screening details	Name	Agent isolation and identification
	Sample	Preputial washing
	Testing at	RVL, CVL
Eligible animals		All male animals
Prevention		Annual sheath lavage
Frequency of testing		Annual
Action on finding a positive bull	Animal	Treat the animals
	Semen	Destroy the collections since last negative test
Quarantine	Duration of quarantine	Minimum 30 days
	Test Schedule	One test, if age is less then 6 months, else 3 consecutive tests at weekly intervals
Additional testing at sexual maturity		Protozoa isolation before bulls are used for semen collection for Al

CHAPTER: III

GENERAL RULES FOR HYGIENE AND SANITATION

A. PREMISES

1. All cracks and crevices in the ceiling and walls are sealed to control pests and insects.
2. Floor mats (preferably washable) are installed at all laboratory entrances and entry to the laboratory restricted.
3. Windows and doors are kept closed, especially when extender preparation and semen processing procedures are in progress.
4. Sink drains are decontaminated routinely with a disinfectant.
5. Floors and horizontal surfaces are cleaned and mopped with a disinfectant solution.
6. Unnecessary furniture, equipment and materials are not kept in the laboratory.
7. Appropriate numbers of U V lights in respect to area of laboratory are fixed with a common operating switch outside the laboratory. These lights are kept on at least for one hour prior to commencement of work in the laboratory.
8. Once U V light is fixed, the date is written on it to check the number of hours used.
9. The immediate work surface, the parts of equipment, etc. supposed to be handled during processing of semen are cleaned with 70% alcohol before commencing the work and after the completion of work.
10. Wearing of clean laboratory foot-wears, clean aprons, hair and mouth masks is insisted upon when entering the laboratory.
11. Do not allow dirty glassware to dry.
12. Immerse and soak used glassware in water immediately after use.
13. Bull apron is to be tied for all bulls under semen collection.
14. Entry of visitor is not allowed during semen collection.

B. SEMEN COLLECTOR

1. Before every collection, hands are to be washed with 0.1% Savlon solution.
2. Wearing aprons and Gumboots is a must.
3. Use sterilized napkins for cleaning the hands before and after collection.
4. Footwear and barn coat are washed immediately after completion of semen collection work.

C. EQUIPMENT

1. The exterior surface of all equipment, furniture is cleaned weekly and all equipment is kept covered by plastic covers when not in use.
2. The semen straw filling and sealing machine are thoroughly cleaned immediately after use.
3. The lens of microscope is gently cleaned daily with lint-free lens cleaning tissue paper.
4. Incubators to maintain artificial vagina are cleaned and disinfected with 70% alcohol.
5. Single distilled water or pure rain water is used in Autoclave and thermos controlled water bath.
6. The water bath is cleaned and filled with fresh water on a regular basis.
7. The thermometer, kept immersed in water bath is cleaned dally to have precise temperature reading.

D. PERSONNEL

1. Keep finger nails trimmed and clean, wash hands, and wear clean lab coat and caps.

2. Do not eat, drink or smoke in lab.
3. Wash hands with soap and water and rinse with 70% alcohol before commencing work in the laboratory.
4. Dry hands with clean towel.
5. Never touch semen bottles with wet hands.

E. BULLS

1. Trim hairs around the prepuce.
2. Wash bulls with brush every day.

CHAPTER: IV

CLEANING

1. COLLECTION YARD

1. Wash the collection yard before and just after semen collection.
2. The area of collection yard is disinfected regularly with spray of appropriate disinfectant.

2. ARTIFICIAL VAGINA (AV)

1. Remove cone and water from the used AV jacket before washing.
2. Clean the cone and AV thoroughly with a soft sponge brush under running tap water and then soak in warm neutral cleanser for about 30 minutes. Then rinse in warm and clean water and finally soak in distilled water for about 20 minutes.

3. COLLECTION TUBES

1. The collection tubes are cleaned under running tap water and then immersed in warm neutral cleanser for 30 minutes. Subsequently they are thoroughly brushed and cleaned three times with running tap water and finally soaked in distilled water for about 20 minutes.
2. These tubes are dried at $100^{0\,C}$ for 1 hour and their mouth is closed with aluminium foil.

4. GLASSWARE

1. The glassware are washed thoroughly with running tap water and soaked in warm, neutral cleanser detergent solution for about 30 minutes.
2. Using appropriate nylon brush, the glassware are cleaned and rinsed with running tap water.
3. Finally the glassware are dipped in distilled water for about 20 minutes and allowed to dry in incubator at $100\,^{0}$C.
4. The open mouth of the dried glassware is closed with aluminium foil.

5. RUBBERWARES

1. The washing and cleaning procedure of rubber wares is same as that of glassware.
2. Care is taken to clean the rubber wares with sponge brush instead of nylon brush.
3. Plastic tubing is cleaned by applying force using syringe.

6. SLIDES

1. The glass slides are immersed in water immediately after use.
2. To clean- prepare boiling water with detergent and boil slides for about five minutes.
3. After cooling, brush both sides of the slides many times.
4. Brush both sides in running water and immerse in distilled water.
5. Wipe water with clean cloth and immerse in a mixture of <u>ethanol</u> and <u>chloroform</u> (8:2).
6. Wipe with clean cloth and keep for next use.
7.

7. Cover slips

1. Soak in distilled water immediately after use.
2. Rinse thoroughly in running water.
3. Rinse in few changes of distilled water.
4. Place in the incubator for drying.
5. Sterilize in sun light for one hour.

CHAPTER: V

STERILIZATION

1. ARTIFICIAL VAGINA (AV)

1. For sterilization, the fully assembled AV is autoclaved at 5 psi Pressure for 20 minutes. During sterilization the AV valve is kept open.
2. The sterilized AV is stored in the incubator at 50 degree C after filling with clean water for next day use.

2. COLLECTION TUBE

Collection tubes are sterilized in hot air oven at 180 ^{0}c degree C for 0.5 hour.

3. GLASSWARES

Glasswares are sterilized in hot air over at 180^0 c for ½ hour.

4. RUBBERWARES

1. Thermo resistant rubber wares are sterilized by autoclaving at 3-4 psi for 10 minutes.
2. The sterilized rubber wares are kept in UV chamber after drying.

5. BUFFER

Buffer is sterilized by autoclaving at 5 psi pressure for 20 minutes.

6. FILTERPAPERS

Filter papers of approximately 15x10 cm size are used for separation of egg yolk. A bunch of such papers are thrashed to remove dirt, if any, and sterilized under UV lamp exposing for more than 10 minutes.

7. MAGNETIC STIRRERS

1. Boil the stirrer for about 15-20 minutes.
2. Hold with sterile forceps.
3. Wrap in aluminium foil.

8. SEMEN STRAWS/CONES/TUBES/MICROPIPETTE TIPS ETC

Sterilize in UV or in direct sun light.

SUMMARY OF STERILIZATION

(A) AUTOCLAVE

S. No.	ITEM	PRESSURE (psi)	TIME (min)
1	Artificial Vagina	5	20
2	Buffer	5	20
3	Plastic tips and suction tubes	5	20
4	Bull apron, Napkins	5	20
5	Thermo-resistant rubber ware	3-4	10
6	Bacteriological media	15	15
7	Distilled water	15	20
8	Surgical equipment	10	10
9	Poly propylein collection tubes	5	20

(B) HOT AIR OVEN

S.N.	ITEM	TEMPERATURE	TIME (min)
1.	Glassware	100/180 Deg. C.	60/30
2	Filling Nozzles	100/180 Deg. C.	60/30
3	Collection glass tubes	100/180 Deg. C.	60/30
4	Filling Needles	100/180 Deg. C.	60/30

CHAPTER: VI

PREPARATION

(A) PREPARATION OF BULL FOR SEMEN COLLECTION

1. Grooming at shed for the bulls under semen collection and wiping is done with sterilized napkins.
2. One day before the semen collection the bulls are exercised for 45 minutes.
3. Prepuce is cleaned with 0.01% Acriflavin solution at the time of semen collection and dried with clean sterilized napkins.
4. Sterilized bull aprons to be tied for all bulls under semen collection.

(B) PREPARATIONS IN THE LABORATORY

1. Clean slides and cover slips are placed on stage warmer set at 37 degree C before commencing the semen collection.
2. 4 ml normal saline is filled in cuvettes for use in photometer.

(C) PREPARATION OF ARTIFICAL VAGINA

1. The water jacket of AV is filled up to 0.5 to 0.75 levels with 50 degree centigrade water.
2. Air is blown into the jacket through the air valve in order to get additional pressure.
3. Temperature in AV is maintained between 45 and 48 degree C.
4. Temperature of the AV cones and semen collection tubes is maintained around 34-37^{0} C
5. To maintain the temperature and to protect the ejaculated semen from ambient temperature, an insulation bag is attached to the AV hose.

(D) PREPARATION OF BUFFER

1. Take 500 ml. of <u>sterilized double distilled rain water</u> in the sterilized volumetric flask.
2. To this, add-
   a) 24.220 gms of Tris
   b) 13.600 gms of Citric acid
   c) 10 gms of Fructose
   d) 64 ml. of Glycerol
3. Allow to dissolve using magnetic stirrer.
4. Make up the total volume to 800 ml. with double distilled rain water.
5. Autoclave this solution at <u>5 psi pressure for 20</u> minutes
6. Upon complete cooling, add antibiotics-
   a. Benzyl penicillin @ 1000 IU/ml
   b. Streptomycin @ 1mg/ml
7. Mix 30 minutes before starting of the semen processing.

(E) PREPARATION OF EGG YOLK

1. The egg yolk is prepared from fresh hen's egg.
2. The eggs on reception are wiped with 70% alcohol. Egg yolk is separated in the sterile zone, under euro air or on laminar air flow table.
3. The forceps (to break the eggs) and hands are wiped/rinsed with 70% alcohol.
4. The shell is to be broken in two halves and white of the egg is drained off in a beaker.
5. The yellow yolk is transferred to a clean and sterilized filter paper and rolled over the filter paper so as to remove the white.
6. The yolk membrane is then punctured by sterile straw/needle to drain yellow of the yolk in a sterile measuring cylinder.
7. Required quantity of yolk is prepared for preparing of extender.

(F) PREPARATION OF SEMEN EXTENDER

On the day of semen collection, 20% (of the total volume of the extender is to be prepared) egg yolk is added to the buffer and thoroughly mixed using magnetic stirrer.

This extender is maintained at 37 degree C in water bath before commencing of semen processing.

(G) pH OF EXTENDER/BUFFER

pH of buffer is important for survival of sperms and quality of semen. Since the laboratory currently uses calibrated automatic digital pH meter, and sometimes another ORION Ag/AgCl SURE-FLOW ELECTRODE (Model No 9165BN) for measuring pH the following steps should be followed:

- Take two buffers of known pH **7** and **4** or **10.**
- Take internal filling solution (4M KCl saturated with AgCl).
- Clean salt deposits from external surface of sensing element with distilled water.
- Slide the fill-hole cover down to uncover fill hole and fill internal filling solution.
- Maintain filling solution level at least one inch above the sample level on immersion.
- The fill-hole should be open when the electrode is in use.
- Shake the electrode to remove air bubbles, if any.
- Two buffers of known pH are used for calibration.
- Rinse the electrode with distilled water first and with pH 7 buffer.
- Press Mode, Calibrate is displayed.
- Press YES, P1 is displayed
- Immerse the electrode in pH **7** buffer.
- When measurement of 7 and message ready is displayed press YES, P2 is displayed
- Rinse the electrode with distilled water, wipe with cotton and dip in pH 4.01 buffer.
- Reading 4.01 and message ready is displayed, Press YES
- Measure is displayed.
- Rinse the electrode again, wipe and immerse in buffer to be measured.
- Note down the reading displayed.

CHAPTER: VII

SEMEN COLLECTION

COLLECTION OF SEMEN USING ARTIFICIAL VAGINA

1. Donor bull is brought near the suitable dummy.
2. Bull is stimulated by giving two false mounts.
3. The glans penis is guided into firmly held sterilized and well prepared AV
4. The AV shall not be shaken after ejaculation to avoid the lubricant; debris may mix with the ejaculated sample.
5. The collection tube with semen is delivered to the laboratory as soon as possible for further processing.
6. For every ejaculation thrust, the AV is changed.
7. Use 12" or 14" AV according to the size of the penis.
8. The second ejaculate is collected about 45 to 60 minutes interval.

CHAPTER: VIII

EVALUATION OF NEAT SEMEN

(A) LABELLING

Collection tubes containing semen should be labelled with bull numbers for identification.

(B) STORING RAW SEMEN

As soon as the raw semen is received, it shall be kept under thermos-controlled water bath at the temperature of 34-37 degree centigrade under Laminar Flow unit.

(C) MACROSCOPIC EVALUATION

As soon as the semen is received in the laboratory, total volume, colour, density and presence of any foreign matter is noted. Normal semen has a uniform opaque appearance free from hair, dirt, pus, urine and other contaminants. Density is graded on a scale of 1.0 to 3.0

1. **COLOUR:** Color of the semen is noted.

2. **VOLUME:** Volume of the neat semen is recorded precisely.

3. **PRESENCE OF FOREIGN MATTER:** Foreign materials, if any the semen is discarded.

4. **DENSITY:** Visual density of the semen is recorded as 1, 2 or 3 (1 for thin and 3 for thick).

5. **SPERM CONCENTRATION WITH PHOTOMETER**

NLBO currently uses **Photometer SDM 6** (Minitub) to measure semen sperm concentration and to decide the volume of extender to be used the following steps are:

1. Install and switch on the set comprising of

- Photometer SDM6
- Microcomputer PE4:PSION with MINICON Software.
- Printer DPT-4133-V .24

2. Using PSION

- System menu is opened and Icons are displayed when turned ON.
- Use ARROW RIGHT and ARROW LEFT and search icon OPL and string MINICON
- Open the string using cursor and pressing ENTER.
- The display shows main menu of MINICON

Minitub-Your Competence in AI
Measure, Calculate and Print Settings Quit

- Select a option by using curser and pressing ENTER.

when first option is selected

"……. waiting for measuring values, Quit with ESC" is displayed.

- Measuring values from SDM 4 Photometer are received in the computer in this mode.
- Press ESC to quit.

When second menu is selected

we see-

Settings
0= Deutch, 1=English sperms/doses(millions) 0<*<3000   20 volume per doses (ml) 0.2<*<150   0.25 printer connected: 0= no 1= yes   1

Select language, sperms/dose, volume per dose and connection of printer as desired and confirm by pressing ENTER when asked if you want to save the settings.

2. Using SDM4 PHOTOMETER

- The photometer when switched on, displays

Method: .. Co

Choice: → Meth

- Type "**11**" for measuring bull semen.
- Then you are asked to control filter wavelength 546 nanometer

11 BULL liner

Filter IL 546? ←

- Take 4 ml. normal saline in a cuvette and insert into the measuring chamber of the Photometer.
- Press ZERO on the key pad of SDM4.
- The photometer is adjusted to 0.000 with normal saline and the cuvette.

0.000 billion/ml is displayed.

(D) PREPARING SEMEN SAMPLE

- Take a 10 mm rectangle cuvette with 4 ml capacity.
- Fill 4 ml of normal saline in it.
- To dilute semen by 200 times add 20 µl of semen in it.
- Mix semen and normal saline well.
- Place the semen sample in measuring chamber of the photometer.
- Press **M** for measurement.
- The result is directly transferred to microcomputer and is displayed on the screen
- If the transmission was OK dialogue is presented to put in parameters of the ejaculate

Input of parameters
Animal: Volume of ej.(ml) : Motility:

Type the name or number of the bull, volume of the ejaculate and motility using ARROW DOWN and ARROW UP, then press ENTER.

When finished, the results will be printed when printer connected and displayed on screen when printer is not connected.

An example of message that will be displayed on the screen:

Animal	:	925
Volume of ej. (ml)	:	5
Density (Bill/ml)	:	1.569
Motility (%)	:	70
Mio. of sperms/dose	:	25
Number of portions	:	280
Volume of dil. (ml)	:	135

….. waiting for meas. values

Quit with ESC !

- Process another ejaculate by putting a cuvette with a new sample in to the measuring chamber and pressing M on the key pad.
- The computer screen after some time may appear empty in order to limit electricity consumption. In this case press ESC to proceed.

(D) MICROSCOPIC EVALUATION

1. MASS ACTIVITY

A drop of raw semen is put on the warm slide without applying cover-slip and mass activity is observed under low power microscope (10X). Good semen samples show a series of rapidly changing swirls waves like clouds and current of sperm motion which is graded on a scale of **+** to **+ + + +** depending on the vigor in wave (**+** for weak vigor and **++++** for strong vigor).

2. MOTILITY

A drop of semen is diluted in 2 ml of extender maintained at 37 degree Celsius.

One small drop of this diluted semen is put on a warm slide placed on the slide warmer of microscope maintained at 37 degree centigrade and covered with a cover slip.

Approximate percentage of progressively motile spermatozoa is observed in different fields of slide at 10 & 20X under a phase contrast microscope.

Any sample showing below 70% progressive initial motility is discarded from further processing.

3. PERCENTAGE OF LIVE AND DEAD SPERM

Percentage of dead sperms is estimated during motility evaluation and semen with less than **80 %** live sperm is discarded.

4. PERCENTAGE OF ABNORMAL SPERMS

Similarly percentage of abnormal sperms also is estimated and semen with more than **15%** abnormal sperms also is discarded.

CHAPTER: IX

EXTENSION OF SEMEN

After macroscopic and microscopic evaluation, the semen, if found good for further processing, is extended with a calculated quantity of extender (the quantity calculated by MINICON software and shown by PSION on the basis of inputs we supplied) in sterilized conical flask so as to pack 20 million sperms per straw.

The laboratory currently follows single-step extension and the extended semen is immediately transferred to filling, sealing and printing machine for further processing of semen.

CHAPTER: X

FILLING, SEALING & PRINTING OF STRAWS

1. PRE-FILLING MOTILITY TEST

Pre-filling motility of the extended semen should be examined and semen with less than **60%** motility should be discarded from further processing

2. FILLING AND SEALING OF STRAWS:

Using automatic filling, sealing and printing machine (IMV IS4), the extended semen is filled in straws using sterilized filling nozzles and sealed by using heat and pressure and then printed straw are automatically collected in collection bucket. But now recently we are using Genomax machine from IMV.

With the help of straw printing machine, the straws are printed with details of:

- Batch number of the Fiscal Year : 1, 2, 3……….51, 52
- The Fiscal Year date : 062/63, 063/64 ……..
- Name of the Bull : BIR, STAR, AJAYA,…….
- Breed and Number of the Bull :

Current practice is to write:

PJ (Pokhara Jersey for Jersey)

PJE (Embryo Transfer born Jersey) and

PM (Pokhara Murrah for Murrah)

and then number- 1, 2, 925, 31 etc.

- Name of organization : NLBO
  Straw photo---

Particular colour straws are used for particular breed and current practice is to use: Green straws for Jersey, Clear/White straws for Murrah and Yellow for Hariana

3. ARRANGING STRAWS & STORING

The sealed semen straws are arranged vertically in wire basket for freezing. Keep laboratory seal end up while arranging the straws in wire basket.

The semen straws after arranging are transferred in the cold handling unit maintained at 5 degree centigrade and should be kept there for **4 hours** before freezing. During this pre-freezing motility tests of semen are carried on.

CHAPTER: XI

FREEZING

Freezing of semen straws at NLBO lab currently is done using Simple Rapid Freezer (FHK made) and the steps to be followed in order to get good result are-

1) Pour LN2 into the freezing tub to a level a little higher than stated level, cover the tub, and cool the inside of the tub for minimum 15 minutes before starting freezing.
2) After cooling, check LN2 level in the tub and maintain it, if it is lower than the stated level.
3) Hang the wire basket with semen straws on its holder in the freezer, and lower the wire basket down using coarse and fine adjustments. It takes approximately 2 minutes to lower the basket to the **0** mark.
4) Leave the basket in this position in the LN2 vapor for approximately 5 minutes (making total of 7 minutes), then let the wire basket further down by using fine adjustment until the basket is completely submerged in LN2.
5) The wire basket is taken out of the freezing tub and immersed in LN2 for evaluation and counting.

CHAPTER: XII

CHECKING POST-THAW MOTILITY

At 0 hour

Post-thaw motility of semen is checked immediately after freezing (0 hr) by thawing one or two random sample straws at 37 degree centigrade for 15 to 30 seconds in water bath. If the percentage of motility in the frozen-thawed semen is below 50%, the particular batches of semen doses are to be discarded.

After 48 hours

The goblets containing good quality semen doses are kept in the Liquid Nitrogen container in the lab. and post-thaw motility of semen is re-examined after 48 hours.

The frozen semen straws are transferred to semen store for storage and distribution, if motility of the semen is found up to the set standard (minimum 50% currently). All the frozen semen doses are stored / dipped in liquid nitrogen.

CHAPTER: XIII

FROZEN SEMEN STORAGE AND DISTRIBUTION

1. SEMEN STORAGE

Frozen semen doses, if found acceptable on checking post-thaw motility after 48 hours of freezing, would be stored in the goblets of 300 straws each. These goblets would be stored in mother containers each allotted for separate bulls.

Liquid Nitrogen shall be replenished at a regular interval depending on the liquid nitrogen evaporation rate of the container (current practice is to refill mother containers every 10th day in summer and every 15th day in other seasons).

2. DISTRIBUTION

The transfer of goblet from one refrigerator to another or between places should be done quickly, especially when the goblet is full with semen doses, and the quantity of Liquid Nitrogen in the container is less.

Transfer of frozen semen straws from one goblet to another is made under Liquid Nitrogen. The distribution of frozen semen straws to the field has to be done after completion of minimum 28 days.

CHAPTER: XIV

QUALITY CONTROL

(A) CHEMICALS

1) The following chemicals with specification only shall be used for preparing buffer
   Tris Sigma 7-9 R
   Citric Acid Monohydrate GR- Merck
   D-Fructose GR – Loba
   Glycerol Excel R – Qualigens
2) Whenever a new brand of chemical is to be introduced in the routine process, examine for post thaw revival rates after conducting few split ejaculate trials (maintaining a control) with the new chemical.

(B) CALCULATION OF SPERM CONCENTRATION-HAEMOCYTOMETER

Concentration of sperms in frozen semen doses, calculated by MINICON software and SDM6 photometer should be checked periodically using Haemocytometer. The steps of using haemocytometer are:

1. 39.9ml. 2% Eosin solution is taken in a beaker.
2. 0.1 ml. sample is added to it and mixed gently.
3. Haemocytometer slide is taken and a cover slip is fixed on it. Production of the Newton ring on cover slip is important to achieve the depth.
4. The Haemocytometer slide is charged with the help of micro-pipette using diluted semen from the beaker and allowed to spread under the cover glass.

Care is taken to avoid presence of air bubble under the cover slip. After waiting for 5 minutes to allow the sperms to settle, the slide is placed under low power objective and number of sperms present in the four corner chambers and one middle chamber (16x5=80 small chambers) are counted.

(C) ESTIMATION OF SPERM CONCENTRATION

1. Sperm concentration = No. of Spermatozoa counted x the multiplication factor x the dilution factor.
2. Total sperm count = Sperm concentration x semen volume.
3. Multiplication factor = 50.000 for spermatozoa counted in small square E1, E2, E3, E4 and E5.
4. Dilution Factor = 20 for 0.1ml. in 39.9 ml.

(D) ASSESSING LIVE AND DEAD SPERMATOZOA

1. 5% Eosin and 10% Nigrosine 3 drops and 5 drops respectively are taken and mixed in a small glass test tube maintained in a water bath at 34 degree C.
2. Tow drops of mixed stain and a small drop of semen are taken on a pre-warmed slide and mixed gently.
3. Two smears are prepared and allowed to dry in the air.
4. Random fields (diagonally) are counted over the slides to obtain a representative figure.
5. 100 sperms are counted under oil immersion objective and Live and Dead sperm ratio arrived directly.
6. Bulls having more than 20% dead sperms in neat semen are advised for sexual rest and correction causative factors.

(E) MORPHOLOGICAL STUDIES OF SPERMATOZOA

1. Type of Abnormalities: Head, Mid-piece, Tail, Proximal droplets.
2. Take a sterilized Borosil glass tube, to it 5 ml. of buffered formal saline is poured.
3. Add 1 to 2 drops of neat semen to above 5 ml. of buffered formal saline, gently shake, incubate at 37^0C for 10 to 20 minutes.
4. Put a drop of the sample on clean glass slide, cover with cover slip and examine under oil immersion objective.
5. 200 sperms are counted from different fields and types of sperm abnormalities are tabulated.
6. Sperm abnormalities and the maximum allowed frequency in normal bull semen are-

a. Head abnormalities-	Young Bull	10%
	Old Bull	20%
b. Mid-piece abnormalities		5%
c. Tail abnormalities		5%
d. Proximal and distal droplets		5%

7. Semen should not be used if the sample contains more than 20% abnormalities put together
8. Bulls having more than 20% primary abnormalities in neat semen are re-examined for three consecutive tests are suggested for culling.
9. Bulls having more than 20% secondary abnormality are advised for sexual rest and correcting the causative factors.

(F) ACROSOME INTEGRITY TEST

1. Spread the neat semen on a pre-warmed slide.
2. Fix by drying and immerse in 5% formalin for 30 minutes at 37 deg. C.
3. Wash the slide in running water and dry.
4. The slide is kept in Giemsa stain for 3 hours at 37 deg. C, wash in water and dry.
5. The maximum permissible level of acrosome disintegrity is 15%
6. Bulls having more than 15% disintegrity are re-examined for three consecutive tests and are suggested for culling

(G) POST-THAW VIABILITY TEST

Viability of Spermatozoa in female reproductive tract before it meets an ovum is a pre-requisite quality for successful fertilization. Post thaw incubation of frozen semen at 37^0 C is a good indicator of in-vitro viability of spermatozoa.

1. Take frozen semen straw and thaw the sample, adopting the standard procedures.
2. Estimate the percentage of progressively motile spermatozoa immediately after thawing ('0' hr.).
3. Incubate the thawed sample (collected in a small test tube) in water bath at 37^0 C.
4. Evaluate the motility of the sample at 1, 2 and 3 hours of incubation.
5. Samples showing higher percentage of motile spermatozoa for longer periods of incubation at 37^0 C are considered as better samples in terms of viability of spermatozoa.
   - 0 hour motility - 40-50%
   - 1^{st} hour motility- 35%
   - 2^{nd} hour motility – 20%
   - 3^{rd} hour motility- 10%
6. Samples not meeting the above specifications should be discarded.
7. Bulls having low percentage of viability are advised for sexual rest and correcting the causative factors.

(H) HYPO-OSMOTIC SWELLING TEST

1. Take 0.1 ml. of frozen thawed semen.
2. Mix it with 1 ml. of HOS medium.
3. Incubate the Mixture at 37^0 C for 30 minutes.
4. Place a drop under cover slip, examine under phase contrast microscope for tail curling.
5. 100 sperm are counted and percentage of HOS sperms arrived directly.
6. Good semen sample may contain 60% to 70% of spermatozoa with Hypo-Osmotic Swelling (Tail curled).
7. Bulls having less than 60% Hypo-Osmotic Swelling sperms are advised for sexual rest and correcting the causative factors.

(I) MICROBIAL EXAMINATION

Microbial examination should be conducted frequently. Four types of examinations are carried out.

1. Aerial count test
   1. Sterile (after keeping it in hot air oven at180^0 C for 30 minutes) Petri Dish is taken.
   2. Under Laminar Air Flow 15 ml. autoclaved (15 psi for 20 minutes) Nutrient Agar Media for non-pathogens and Brain heart infusion agar for pathogens is poured in the Petri Dish. The media has to spread so as to it covers the Petri Dish completely.
   3. The Petri Dish is exposed for 10 minutes in the area to be tested
   4. The Petri Dish is closed and incubated for 48 hours at 37^0 C.
   5. The colonies are counted after 48 hours.
   6. The areas tested are Laboratory, Extender preparation room, Sterilization room, Cold Handling Units, Laminar Air Flow Stations, UV Chambers, Autoclave, Incubator, and Hot Air Oven etc.

   <u>The maximum permissible level is 10 colonies per area.</u>

2. Rinse Test
   1. The instruments and glassware to be tested are rinsed with autoclaved distilled water and collected in a sterile beaker.
   2. 1 ml. of rinsed water is taken using a sterile pipette and inoculated in a sterile Petri Dish under the Laminar Air flow.
   3. 15 ml. of media is poured in the Petri Dish.
   4. Petri Dish is incubated for 48 hours at 37^0 C.

5. After 48 hours the colonies are counted.

The maximum permissible level is 10 colonies.

The instruments and glassware tested are sterilized AV, UV exposed empty straws, conical flask, measuring jar, collection tube, and filling tube.

3. Working Solution Test

1. Under Laminar Air Flow, 1 ml. of autoclaved working solution is inoculated in a sterilized Petri Dish.
2. 14 ml. of media is poured in the Petri Dish.
3. The Petri Dish is incubated at 37^0 C for 48 hours.
4. After 48 hours the colonies are counted.

There should not be any colonies in the working solution. Working solutions tested are distilled water, buffer and extender.

4. Batch Test

1. Single straw from each bull of same batch taken and pooled in a sterile Test Tube A.
2. From it 0.1 ml. semen is taken in another test tube B.
3. To this 9.9 ml. of autoclaved distilled water is added.
4. Under Laminar Air Flow 1 ml. is taken from Test Tube B and inoculated in a Petri dish.
5. 15 ml. of autoclaved media is poured.
6. Petri Dish is incubated at 37^0 C for 48 hours.
7. After 48 hours the colonies are counted.
8. As the dilution rate is 1 in 100 one colony counted = 100 colonies.

There should be no colonies.

5. Bullwise Test

1. A single straw from the bull to be tested is thawed and taken in a test tube.
2. To it 9.75 ml. of autoclaved distilled water is added under Laminar Air Flow
3. From it 1 ml. is inoculated in a Petri dish
4. 15 ml. of autoclaved media is poured.
5. The Petri dish is incubated at 37^0 C at 48 hours.
6. After 48 hours the colonies are counted.
7. As the dilution rate is 1 in 40 one colony counted = 40 colonies

There should be no colonies

CHAPTER: XV

MEDIAS, BUFFERS AND STAINS PREPARATION

(i) BACTERIOLOGICAL MEDIA

A. Bacteriological Media for Non-Pathogens

1. Take 500 ml. of autoclaved distilled water in 1000 ml. beaker.
2. Add 14 gms of nutrient agar and boil it to dissolve the media completely.
3. Autoclave it by keeping under15 psi for 20 minutes.

B. Bacteriological media for Pathogens

1. Take 500 ml. of autoclaved distilled water in 1000 ml. beaker

2. Add 26 gms of Brain heart infusion agar and boil it to dissolve the media completely.
3. Autoclave it by keeping under15 psi for 20 minutes.

(ii) FORMAL SALINE PREPARATION

1. Take 100 ml. of stock buffer solution in 1000 ml. beaker.
2. Add stock Sodium Chloride- 150 ml.
3. Add 37% formalin – 62.5 ml.
4. Add distilled water – 500 ml.

<u>a. Stock Buffer Preparation</u>
1. Take solution A – 200 ml.
2. Take solution B – 80 ml.

<u>b. Solution A preparation</u>
1. Di-sodium di-hydrogen phosphate = 21.682 gms.
2. Add distilled water = 500 ml.

<u>c. Solution B preparation</u>
1. Pottasium Phosphate = 22. 754 gms.
2. Add Distilled water = 500 gms.

<u>d. Stock Sodium Chloride preparation.</u>
1. Sodium Chloride = 9. 01 gms.
2. Add distilled water = 500 ml.

(iii) EOSIN NIGROSIN STAIN PREPARATION

1. 3 drops of 5% Eosin
2. 5 drops of 10% Nigrosin
3. Incubate in water at 34^0 C.

<u>a. 5% Eosin Stain preparation</u>
1. Eosin 5 gms.
2. 3% Sodium Citrate buffer 100 ml.

<u>b. 10% Nigrosin Stain preparation</u>
1. Nigrosin 10 gms.
2. 3% Sodium Citrate buffer 100 ml.

(iv) PREPARATION OF HOS MEDIA

Preparation of Sodium Citrate and Fructose HOST Medium (75 mosm) by making the following mixture:

1. Measure 0.367 gm of sodium citrate and dissolve in 50 ml. of triple glass distilled water.
2. Measure 0.675 gms. of fructose and dissolve in 50 ml. of double distilled water.
3. Mix equal volumes of sodium citrate and fructose solution.

This is known as HOS media.

(v) GIEMSA STAIN PREPARATION

1. Giemsa stock solution – 3 ml.
2. Triss buffer – 2 ml.
3. Distilled water – 45 ml.

<u>Stock Giemsa Stain</u>

Giemsa stain – 3.8 gms.
Methanol (AR grade) – 375 ml.
Glycerol (AR grade) – 125 ml.

Giemsa stain is ground with absolute methanol in a glass pestle and mortar. Glycerol is added and this stock stain mixture is stored at 37^0 C for one week During the period the stock staining solution is mixed well for few minutes every day by shaking the bottle.

(vi) 2% EOSIN

2 gms. of Eosin
100 ml. of distilled water

Annex IV AI delivery: Standard Operating Procedures for inseminators

AI Center, Premises and AI Equipment Set

i. Keep the premises of the AI Centre clean.
ii. Allocate adequate space for liquid nitrogen container, semen refrigerator, and other equipment; ensure the room and space gets minimum dust on it. Clean the space daily.
iii. Keep canisters and semen straws with their label intact. Canisters must be tagged with a complete description of semen.
iv. Keep your A.I. kit up to date, clean and before leaving for attending farmer's call, check that the A.I. kit has the following items:
   a. Scissors, thermometer, thawing tray, forceps, singly packed sheaths, AI Gun with its holder, plastic gloves, clean towel, thermos-flask with hot water, an apron, etc.
   b. An LN refrigerator with semen doses as per breeding plan or desired one by the farmer. Always be consistent with your AI records so that you can identify which semen dose is to be delivered to which cluster of your area and the farmer.
v. You need to be well informed in advance, with the schedule of delivery of liquid nitrogen and semen doses. Ensure you are present at the center on the scheduled day and time of semen and liquid nitrogen delivery.
vi. Always keep the container with an adequate quantity of liquid nitrogen. Your semen doses should always be submerged in LN.
vii. Keep the liquid Nitrogen container in a location that allows you to see into the neck tube of the container, and ease in withdrawal and replenishment of semen and liquid nitrogen. The surrounding should be well ventilated, dry and dust free.
viii. Clean AI gun, scissors, and other accessories whenever they get soiled or at least once a week with hot water and air dry them. Sanitize the AI gun and the scissor with Isopropyl alcohol after drying. The AI Gun piston and the scissors should be wiped clean with water after each insemination. Surgical spirit and soaps are lethal to semen, hence should not be used to clean equipment.
ix. Maintain the liquid nitrogen level above the straw level in 1.5/2/ 3 liters capacity containers.
x. Measure the liquid nitrogen level of 30 liters containers weekly with the help of measuring scale. Maintain the record of measurements to monitor its evaporation rate.
xi. Carry the required semen doses in the liquid nitrogen container to farmer's door step. Never carry semen straws in pocket/ thermos-flask / polythene bags filled with water/ice etc.
xii. Maintain an accurate semen inventory, know your stock and when to purchase or place an order.
xiii. Always attach the paper tag provided with each goblet to the requisite canister of the container to identify the type of semen in each canister.

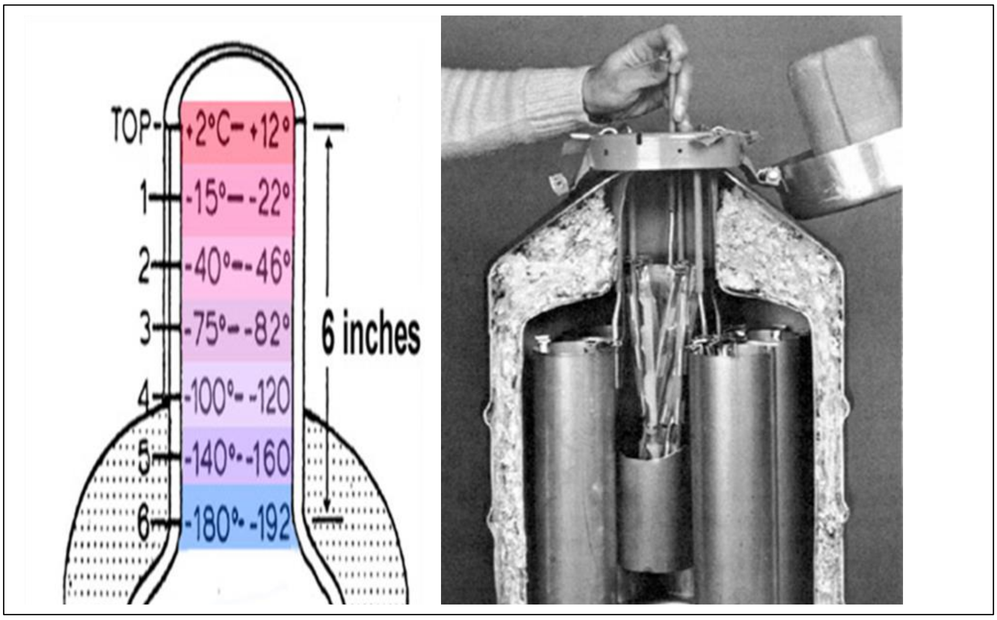
Semen storage and straw removal from the container

i. Storage flasks must be handled according to the manufacturer's instructions and are more fragile than they may appear. They are the two-layer vacuum flasks.
ii. Keep the flask in a secure, well-ventilated area, replacing the stopper quickly to reduce liquid nitrogen evaporation (loss).
iii. Check nitrogen levels daily and top up when required.
iv. Removal – keep the goblet as far down in the neck of the flask as possible when handling straws.
v. If it is necessary to bring the goblet up into the neck of the flask, then following a period of 15 sec maximum, move the canister to the bottom of the flask to allow the canister to re-cool, before you attempt to bring the goblet up again.

Technique of Insemination

Preparatory works:

i. Ensure you have good transport means and a backpack that keeps your AI equipment safe while you are traveling.
ii. After reaching farmer's place, first, identify cow/buffalo and study the past breeding records and herd health, specifically reproduction history of the animal. Ensure, the animal is not pregnant, though it came into estrus.
iii. Examine the animal externally and ascertain that animal is in heat. The best sign of heat is clear, transparent, viscous and ropy vaginal discharge among others. Proceed with the preparation of gun only after *per rectal* examination of cow's genitalia to ensure the animal is in heat and the time is right for the insemination.
iv. The chance of AI success is greatly increased when the cow is relaxed; stands on a level surface with plenty of grips though the cow should also be appropriately restrained. Use an area
v. which is already familiar to the cow, with provision made for food and water, if possible
vi. Wash your hands.



NB: Before thawing the straw, check the water temperature; it should be at around 38^0C, or as instructed by the Semen Station (NLBO). Particular care should be taken with sexed semen for optimum results, it may require slightly longer and warmer thawing temperatures.

Thawing of semen straw: Always remember that the principle of thawing is to bring semen temperature to the core body temperature of the species you are dealing with at the soonest possible time (within a few seconds). This has to take place within the temperature range of physiological/ biological phenomenon (not too cold or too hot); i.e. about 38^0C (101^0 F) in case of cattle and buffalo. For example, if you thaw your semen straw in a water-bath of 42^0C, the time required would be 15 second or even less.

Removing straw from the canister: Always withdraw only one straw at a time from your canister even if you have to inseminate two or more cows in a visit. Remove semen from the canister with a forceps, never with your hands. Before holding the straw by the forceps, cool its tip in LN vapor for a second or two. While taking out, raise the canister just high enough – not above the frost line (lower neck of your refri.). Remove the straw within 7 seconds. Follow a 5-second rule – if you fail to pick up a straw with the forceps within five seconds, submerge the canister in the LN and lift again. The essence of this step is to ensure that partial thawing of other straws does not take place while you are handling canister and withdrawing a semen straw. **Partially thawed straws if re-frozen conception rate is greatly compromised (reduced).**

Thawing: The straw should be removed from the flask with a forceps and it is submerged in the water meant for thawing. Keep the straw in a horizontal position to avoid excessive load on the straw seal while semen volume expands during thawing. Leave straw in water for 20- 25 sec. for a 0.25ml straw and 35 - 40sec for a 0.5ml one. This is because, as 0.5 ml straw has a larger diameter, it will require more time to thaw; thawing of semen at the core (center) of the straw requires more time.

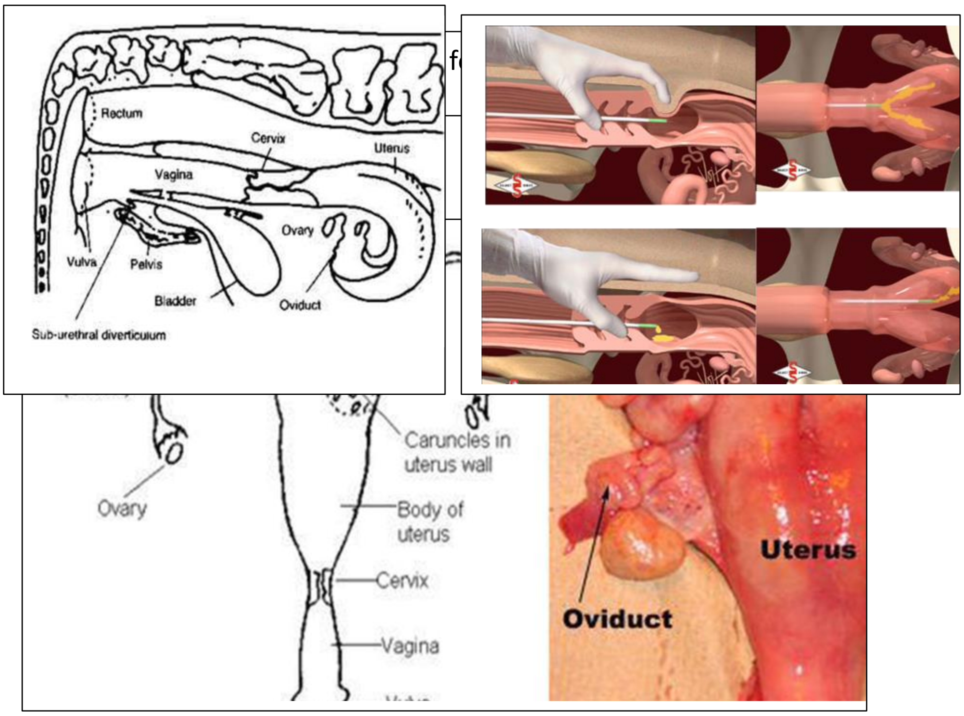
Insemination

1. After thawing, wipe the straw with a dry towel or tissue paper and place it in the gun, which should have been pre-warmed by rubbing between the hands (again remember, we are warming the gun to bring its temperature close to cow’s body temperature so that there will be no/less temperature shock to sperm cells while the straw surface comes in contact with the gun.

2. Before loading the straw in the gun, ascertain that air space in the straw is at the laboratory seal end. Load the straw into the gun and make a clean cut at a right angle with a straight and sharp scissor just below the laboratory seal. Cut the crimped straw end at a 90^0 angle to avoid any semen leakage from uneven spaces between the cut end of the straw, gun, and tip of the sheath. Take out the sheath by holding the bottom of the sheath from the sheath packet and place the sheath on the gun, then secure the sheath firmly with “O-ring” lock.

   NB: Management of time between thawing and Insertion of a gun in the female tract is very important. Now, you know that the temperatures of the thawed semen, AI gun and the female reproductive tract of the animal you are about to inseminate are almost the same, is about 38^0C. You must be aware of the ambient temperature at the time you are doing insemination and the influence it can exert on semen straws. For example, in the winter temperatures in Kathmandu valley in morning hour is almost zero, this temperature will lower the temperature of your gun, sheath, and straw within a minute or two. This can pose a cold shock to sperm cells. If such a reduction in temperature occurs below 21^0C then changes in the sperm cell membrane initiate. You have to be prompt in such instances. Similarly, if the ambient temperature is too high, similar is the case. You should never expose loaded AI gun to direct sunlight.

3. Wear shoulder-length plastic glove, preferably on the left hand and hold the gun with the right hand.
4. Lubricate the gloves with liquid paraffin or any other suitable lubricant before proceeding to the rectum.
5. **Finding the cervix:** the initial landmark is the cervix and this should be located before inserting the gun. The cervix is normally found on the pelvic floor ar near to pelvic rim, but in older cows, it may have moved slightly to one side. Consult the senior or a vet if the cervix is pulled down inside the abdomen and is difficult to manipulate, as the cow could be pregnant or suffering from a uterine infection.
6. After locating the cervix, use the elbow to exert downward pressure on the vagina. This will help bring apart the lips of the vulva, in preparation for the AI gun. The lips should be wiped clean, with the gun inserted past the vestibule and into the vagina.
7. To avoid inserting the gun towards the opening to the urethra, run the gun tip gently along the roof of the vagina until the cervix is reached. The gun should be inserted almost at an angle of more than 45^0 and finish reaching service horizontally.
8. The gun should be inserted as soon as possible after priming, to preserve semen quality, maintain the temperature changes and other possible consequences.
9. Insemination is a two-stage process: Guide the AI gun, so that it is engaged in the cervix



10. Pass the cervix over the AI gun. The blind pocket around the cervix can make it difficult to maneuver the gun into the cervical canal entrance. To resolve this, push the cervix as far

forward as possible while closing the pocket with your grip. Once the tip is in the canal, you should feel a gritty sensation.

11. Aligning and Passing AI gun through cervix: line up the gun with the cervix and pass it through the canal, manipulating the cervix back over the tip of the gun. Feel the tip of the gun at internal os by gently moving the gun tip forward to ensure that the gun is in the correct place (just at the internal os). Be certain the gun tip is not caught in a thin area between cervical rings or vaginal folds.
12. Once the gun is just through the cervix, you should feel a release in resistance to the gun.
13. The semen should be deposited into the short chamber of the uterine horns, which are located on the other side of the cervix.
14. If you put your index finger over the end of the cervix, you will feel where the top pokes through and this is the area where the semen should be deposited.
15. It is where the cervix ends and the uterus begins.
16. Care should be taken to avoid placing the semen into just one horn. In addition, the walls of the uterus are extremely delicate and easily damaged.
17. Deposit the semen slowly, by counting 5,4,3,2,1 (take about five seconds).
18. Be careful to avoid blocking off one of the horns; this can occur if the cervix is gripped too hard or a finger gets in the way.
19. If the animal moves, STOP. Wait till the movement stops.
20. Hold the shoulder of the gun between your ring and middle fingers and push the gun piston with your thumb slowly (5 seconds) to deposit the semen just outside the internal os to allow semen to drain into the body of the uterus. Gently remove the gun and check for abnormal discharge and a complete semen deposit.
21. Recheck semen ID – bull and batch number.
22. Properly dispose of the sheath, gloves and tissue papers. Clean gun if needed.
23. Do not reuse sheaths; splitting straws increases the risk of disease spread and can reduce pregnancy rates.
24. Soiled insemination guns should be cleaned after use and treated with boiling water every few weeks. Disinfectant can damage sperm.
25. Use clean protective clothing and a fresh disposable glove for each insemination.
26. Record breeding information in the specified A.I. cow/ A.I. buffalo register provided by NLBO/LBO or VHLSSC or LSS.
27. Blood on the gun tip and on the gloves indicate that too much force was used to pass the gun – be gentle and patient with the animal.
28. Ask the farmer to release the animal and let her calm down.

Post Insemination Advice to Farmer

1. Always respond to calls made by the farmers. In case there is a likelihood of any delay, inform the farmer about the expected time of visit. Practice a culture of referring to your colleague inseminator if you fail to meet the appointment. This enhances your trust in the community.
2. Ask farmer to keep the animal under observation for next 12-24 hrs, and to note whether heat signs subsided or not. There are frequent instances of long oestrus period leading to delayed ovulation.
3. If signs of heat persist even after 18-24 hrs. call for repeat AI, otherwise, observe for heat symptoms after 18-21 days and also after 36-42 days.
4. Inform the farmer to save the animal from other bulls during the remaining part of present heat.

5. If the animal does not repeat heat at 18-21 days intervals for two consecutive times, call Inseminator for pregnancy diagnosis after 2.5 months from the date of insemination.

Post-insemination follow-up by the Inseminator

1. Follow or inquire the status each and every animal you have inseminated after around 21 days to find out whether it has repeated. This is the novel way you build trust in your practice area.
2. Follow each and every animal inseminated for pregnancy diagnosis within 3 months and record the date and result of pregnancy diagnosis in the register/ format provided.
3. Send your progress and records to LSS/VHLSSC/NLBO on a monthly basis in the format provided by NLBO.
4. Follow each and every pregnant animal and record calving detail of the animals inseminated in the register/ format provided by NLBO.
5. Maintain all records related to artificial insemination, pregnancy diagnosis, and calving and money transaction.
6. Advise farmers on proper heat detection, feeding, management and health care of animals.

NB: Serving cows that are already pregnant: serving a pregnant cow carries the risk of breaking the cervical seal and calves can be lost this way. The cause of this problem can be a failure to properly co-ordinate a breeding strategy with the vet. Poor records: records should be reviewed regularly and success rates evaluated. Send semen samples to your vet at intervals as a quality check.

Checklist for inseminators for self-assessment of skills on insemination technique

	Yes	No	
1			I use a new glove for every insemination.
2			I lubricate the glove with mineral oil or a commercial A.I. lubricant.
3			I speak to and touch the animal to make her aware of your presence.
4			I massage the animal, and also massage the anus with a mineral oil or a lubricant.
5			I am gentle in entering the rectum by forming a cone with your fingers – no bleeding incidences occur
6			I am gentle and thorough in cleaning manure from the rectum.
7			I check the uterus for any abnormal condition.
8			I always clean manure from the vulva and from the underside of your arm with a paper towel.
9			I spread the vulva by pulling down with your arm in the rectum. I generally do not ask farmer to assist for this.
10			I am gentle in passing the gun smoothly through the vagina to the opening to the cervical canal — the cervical external os. I maintain angularity initially and then maintain the gun horizontal with th vertebral column of the cow
11			Place the tip of the gun into the external os.
12			Hold the cervix ahead of the gun's tip; handle and manipulate the cervix to allow the gun to pass without injuring cervical rings and wall.
13			I always check for pregnancy and avoid passing the gun through the cervix if pregnancy is suspected. Though about 105 of the pregnant cows might exhibit estrus, cervical seal still remains intact. Pregnancy is indicated by a "sticky" mucus plug.
14			I place my index finger at the far end of the cervical canal opening.
15			I gently move the gun tip forward until I feel it with my finger.
16			I pass the gun tip ¼ inch past the end of the cervix.
17			I am successful in avoiding the gun tip to be caught between cervical rings. If it happens, I can handle it by slightly moving the cervix forward and then realigning it.
18			I concentrate on accurate semen placement during deposition.
19			I firmly hold the cervix while keeping the index finger in contact with the top of the gun tip.

20			I hold the shoulder of the gun between my ring and middle fingers.
21			I hold my right hand against my left arm to ensure that the gun is not pulled back out of the cervix during the moment of the semen deposition.
22			I slowly push the plunger into the straw gun (about 5 seconds).
23			If the animal moves, I stop the deposit. I wait until animal stops moving, check positioning, and continue to deposit.
24			I gently remove the gun and check for an abnormal discharge and a complete semen deposit.
25			I record all the relevant information, for example, when, and to what sire, the animal was bred, semen batch no and semen source.

Annex V Workshop Recommendations (Breeding Strategy)

The consultants of Breeding team and Feed and Feeding team conducted four state-level interaction workshops, during May 2019 (see below dates and places). The workshops participants constituted State Level Stakeholder Dialogue Platform members, several invitee stakeholders and farmers (see participant lists). This report compiles the information from these four workshops related to the assignment "Development breeding strategy and action plan". The objectives of the workshops were to:

- Orient stakeholders on the current state of breeding practices in the country
- Collect inputs for the development of breeding strategies and action plans for the country in general and NLSIP in particular
- Work out some management systems of stakeholders roles in the implementation of the breed improvement programs of dairy animals and goats.

The main recommendations are synthesized and summarized from the issues/concerns raised by participants during the discussions on working papers presented by the consultants in the workshops in the plenary sessions, group works of the participants, and their presentation. The salient features of the workshops and key recommendations made towards the formulation of the breeding strategy and action plan are summarized below.

I. Biratnagar (08 May 2019)

Number of participants: 55
Men: 49
Women: 6
Chairperson: Dr. Lekh Raj Dahal, Director, Directorate of Livestock and Fisheries Development, State 1.

Key recommendations

I. Management of Genetic Improvement Program - Farmer Organization/Cooperative Role

- The ownership of the entire breed improvement program should remain with farmers associations/union of cooperatives and primary cooperatives.
- Milk Cooperatives are the right institutions to monitor and authenticate the production records.
- For data recording, commercial farms should also be given priorities. These farms should participate in the program and express commitment for production of heifers, and goat kids on an annual basis.
- There should be output based incentives for rearing female calves.
- Farmers training facilities should be created in partnership models at cooperatives/farmers alliance level.
- Trainees (farmers and technicians for breeding services) should be nominated from cooperatives and farmer groups
- Some incentives must be built in for farmers for participating in the PPRS program

II. Breeding and Artificial Insemination Service Management

- Financial support should be provided from State and Federal governments for the entire AI program in all the municipalities, keeping cooperatives in the semen and liquid nitrogen distribution network.
- Refresher training for state-of-the art technical skills to inseminators – NLBO should be responsible for organizing such training.
- Liquid nitrogen and semen distribution – make it easy, create/allocate space and infrastructure at LSS of the municipalities and VHLSSC – both semen and nitrogen must be accessible to both government and private inseminators.
- PPR recording system – inseminators can do field work in coordination with municipalities and milk cooperatives, incentives for them should come from NLSIP.
- Proper schedule and transportation channel for semen and liquid nitrogen is urgently required.
- AI service should be incentivized by local government – Ward offices should pay directly to inseminators based on the records submitted.
- License of AI – Should be issued from LBO or NLBO after training and skill test.
- Decentralize liquid nitrogen procurement – any inseminator or LSS of the municipalities be able to collect nitrogen from NLBO authorized oxygen plant at the state/municipal level.

II. Hetauda (15 May 2019)

Number of participants: 69
Men: 63
Women: 6
Chairperson: Dr. Chet Narayan Kharel, Chief, VHLSSC, Makawanpur

Key Recommendations:

- Some incentives must be built in for farmers for participating in the PPRS program. Farmers' cooperatives and district unions of cooperatives can manage AI service system and performance records. The ownership of the entire breed improvement program should remain with farmers' groups, union of cooperatives and primary cooperatives.
- For data recording, commercial farms and larger farms should be included – These farms should participate in the program and express commitment for production of heifers. Calf rearing needs to be ensured – quality of the future cows depends on the factors/nutrition calf received and are grown up.
- Program planning should be in consultation with farmer institution and farmers training facilities need to be developed at cooperatives level.
- Trainees (farmers and technicians for breeding services) should be nominated from cooperatives and farmer groups. Real farmers can participate in on-site training.
- On a contract basis for a joint project, financial support from State and Federal governments should be provided for the entire AI program including the purchase of liquid nitrogen.
- Refresher training for state-of-the-art technical skills to inseminators from LBOs and NLBO
- Liquid nitrogen and semen distribution – make it easy, space and infrastructure at LSS of the municipalities and VHLSSC – must be accessible to both government and private inseminators

- PPR recording system – inseminators can do field work, incentive from the government is essential.
- AI service should be incentivized by local government – Ward offices should pay directly to inseminators based on the records submitted.
- License of AI – after training and skill test
- Decentralize liquid nitrogen procurement – any inseminator or LSS of the municipalities be able to collect nitrogen from NBO authorized oxygen plant at the state/municipal level.

III. Butwal (26 May 2019)

Number of participants: 70
Men: 66
Women: 4
Chaired by Secretary, Ministry for land management, Agriculture and Cooperatives, State 5

Key Recommendations

A. Management of Genetic Improvement Program - Farmer Organization/Cooperative Role

- Farmers groups/cooperatives can play a role in identifying the best animals for breeding based on performance records
- Cooperatives and commercial farms need quality technical service but are not in a position to bear the cost of mobilizing a technician/doctor. In the initial years, governments should allocate technicians/doctors for performance recording and milk analysis and bear their remuneration. These technicians need to be technically responsible to local governments and cooperatives.
- Municipality Livestock service section should be equipped with facilities and equipment for performance recording. Cooperatives will play its role in the identification of animals by mobilizing technicians allocated for this program.
- Cooperatives should be trained, built their capacity and made responsible for the management, monitoring, reporting and final selection of the breedable animals.
- Output-based grants for the rearing of calves is a must for successful implementation of breed improvement programs
- Intensive training programs including FFS, workshops, and seminars be organized as additional events for capacity building of farmer institutions.
- Framer friendly computer-based data management system needs to be in place, cooperatives' existing computer facilities could be part of this system operation.

B. AI and Breeding Service Management

Services/activities	Who is responsible	Delivery mechanism
Procurement and distribution of liquid nitrogen for semen storage	State government VHLSSC	Ensure liquid nitrogen is accessible and delivered to each AI centers of the municipalities and AI centers managed by private inseminators. Inseminators would be able to refill at LSS of the municipality and or VHLSSC
Semen doses	NLBO and LBOs	Ensure quality, fertility, and genetic merits
Management of inseminators	License from NLBO	Competences and certification

	Technically responsible to LSS of the municipality and or to Cooperatives	Appointment from or registration (for private inseminators) at municipalities Regular fresh and refresher training On the spot monitoring Semen use as per breeding plan
Code of conduct and adoption of SoPs.	Technical guidelines are prepared from NLBO and circulated.	A mechanism for monitoring and assessment of inseminators' technical skills.
Sire selection and procurement	NLBO, LBO and VHLSSC	Identify farmers, Make provision for buy back guarantee. Procure selected male calves from farmers in time.
Health examination and certification	VHLSSC and Veterinary laboratories	

IV. Pokhara (30 May 2019)

Total participants: 84
Women: 10
Men: 74
Chairperson: Dr. Man Bahadur Pun, Director, Directorate of Livestock and Fishery Development, State - 4

Key recommendations

Breed Improvement Breeding Services Management

- There are too many problems associated with the quality of semen and delivery of liquid nitrogen. Procurement of liquid nitrogen and delivery mechanisms be decentralized and State government and Municipalities be made responsible for procurement and distribution of liquid nitrogen for the AI programs in the respective states
- Semen straws should be of good quality, certified and made available to each inseminator irrespective of whether the inseminators are public or private sector service providers
- Primary cooperatives and large commercial farms are given responsibility for the management of breed improvement programs especially for data recording, reporting, monitoring and selection of the animals.
- Calf rearing: Support/grant for rearing female calves of cattle and buffalo on output/final product basis (heifers grown and/or pregnant).
- There must buy back guarantee for the procurement of the male calves produced from the breed improvement programs
- Herd performance and milk analysis records be maintained by primary cooperatives and large commercial farms. This must be made mandatory by law and guidelines. Monitoring be carried out by LSS of the municipalities and VHLSSC officials
- Projects and government programs must continue support for delivery of AI service its expansion in new areas.
- All breeding animals be recognized and certified for expected productivity based on their pedigree records.