

Advancing Women's Participation in the Livestock Vaccine Value Chain in Nepal,
Senegal and Uganda

Country Gap Report

Nepal

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Abbreviations

ADS	Agriculture Development Strategy
APP	Agriculture Perspective Plan
CVL	Central Veterinary Laboratory
DIVA	Differentiation between Infected and Vaccinated Animals
DLS	Department of Livestock Services
DLSO	District Livestock Service Office
FMD	Foot and Mouth Disease
GDI	Gender Development Index
GDP	Gross Domestic Product
GESI	Gender Equity and Social Inclusion
GII	Gender Inequality Index
GNI	Gross National Income
GoN	Government of Nepal
HDI	Human Development Index
IDRC	International Development Research Centre
LVVC	Livestock vaccine value chain
MoAD	Ministry of Agricultural Development
MoALD	Ministry of Agriculture and Livestock Development
MoLD	Ministry of Livestock Development
MoPE	Ministry of Population and Environment
NARC	Nepal Agricultural Research Council
NCP	The Nepal Communist Party
NPR	Nepalese Rupee
PPR	<i>Peste des Petits Ruminants</i>
RVL	Regional Veterinary Laboratory
UF	University of Florida
V/CAHW	Village/community animal health worker
JT	Junior Technician
JTA	Junior Technical Assistant
VET	Veterinarian

Introduction

University of Florida (UF) in partnership with the Canadian International Development Research Institute (IDRC) is implementing a three-year project called *Advancing Women's Participation in the Livestock Vaccine Value Chain in Nepal, Senegal and Uganda*. The goal of the project is to understand women's roles and participation in the selected poultry and small ruminant value chains by evaluating issues of intersectionality on women's involvement in the livestock vaccine value chains (LVVCs) and providing capacity development to community animal health workers (CAHWs, or in the case of Nepal, village -V/CAHWS) to increase female livestock keepers' participation in LVVCs. The primary objectives of this project include:

O1: To design a gender and intersectional mapping tool for small ruminant and poultry vaccine value chains, and testing it in Nepal, Senegal and Uganda.

O2: To evaluate the impacts of gender, intersectionality and other site/country specific characteristics (socio-economic, technical, political) on women's entry and effective participation in and benefits from the LVVC.

O3: To remove barriers for women's entry and participation in the LVVC by applying Gendered Intersectional Transformative Approach (GITA) through various modes of training and innovative interventions that will lead to their inclusive participation in LVVC.

The project is divided into three stages in all three countries. This report focuses on Nepal. The purpose of the first stage is to map the LVVC, particularly, the one for pestes des petit ruminants (PPR) vaccine in the goat pocket areas of Nepal, but specifically in the western, mid-western, and eastern regions. The primary focus is to determine how the current PPR vaccine value chain (VVC) functions in terms of delivering vaccines to or involving female livestock keepers in the vaccine distribution value chain, as well as the related attitudes and perceptions of various LVVC actors on women's involvement in the LVVC. Additionally, the mapping is designed to capture how gender intersects with other identities of the women such as caste, ethnicity, age, wealth, education, religion, and livelihood. The second stage will focus on designing a gendered intersectional transformative training program for V/CAHWs to help them engage or better serve the female livestock keepers. The third stage will focus on systematic review and meta-analysis of findings from stages 1 and 2 of project activities to identify the main levers and barriers at each node of the LVVC and develop an analytical framework to assess factors underlying women's limited engagement in the LVVC and strategies to overcome the barriers.

This country report serves as a background to launching value chain mapping of the PPR vaccine in Nepal.

Country profile

Socio-economic and political context

Nepal is a low-income multi-ethnic country in South Asia which is run as a federal parliamentary republic with multiparty democracy. Nepal consists of seven provinces: Gandaki Pradesh, Karnali Pradesh, Province No 1, Province No 2, Province No 3, Province No 5, and Sudoorpashchim Pradesh. Kathmandu is the capital city and Hindu is the majority religion (81.3%) (CIA, 2019). In 2011, Nepal had 123 spoken languages recorded as mother tongues – used since early childhood. Most of the population speaks Nepali (44.6%) and Maithili (11.6%) as the second largest Nepalese language. In terms of nationality, Nepal is characterized not by ethnicity, but by citizenship, an allegiance that recognizes different national origins. In 2011, 125 castes/ethnic groups were reported where Chhetri was the dominant group – 4,398,053 people (16.6%) – and Brahman-Hill was the second biggest group – 3,226,903 people (12.18%) followed by Magar (7.12%), Tharu (6.56%), Tamang (5.81%), Newar (5.03%), Muslim (4.39%), Kami (4.75%), Yadav (3.98%), Rai (2.34%), and the rest of the caste/ethnic groups with less than 2% of the population (MoPE, 2017).

Nepal is a landlocked country with a total area of 147,181 sq km (0.03% of the total world land area). It borders with China and India (Figure 1). Nepal is the home to the world’s tallest mountain – Mount Everest – and the third tallest mountain – Mount Kanchenjunga (CIA, 2019). Based on topography, the country can be divided into three zones that are characterized by physical features, climate, landscape, and elevation. Covering 35% of the total land area, the mountain zone is on the range of rocky Himalayas at 4,877-8,848 m above sea level. The biggest part is hill zone (42%) at 610-4,877 m above sea level with many valleys and river basins fit for human settlement and agriculture. With 23% of the total land area, the Tarai zone is the most productive area at 0-610 m above sea level (MoPE, 2017). In this zone, the temperature in summer and winter can reach 30-25°C and 10-15°C, respectively; while in the hill zone, temperature varies from 25-5°C in summer to <0°C in winter. In the mountain zone, average annual temperature ranges <0-5°C in winter and 10-15°C in summer (World Bank, 2011). Forest covers around a quarter portion of the land (25.4%), sparsely from the mountain to the hill area (Figure 2). Agricultural land (approximately 28.8%) consists of arable land, permanent pasture, and permanent crops, located, mainly, in the hill area and in the southern Tarai area (Figure 2) (CIA, 2019).



Figure 1. Map of Nepal (TEXAS, 1990)

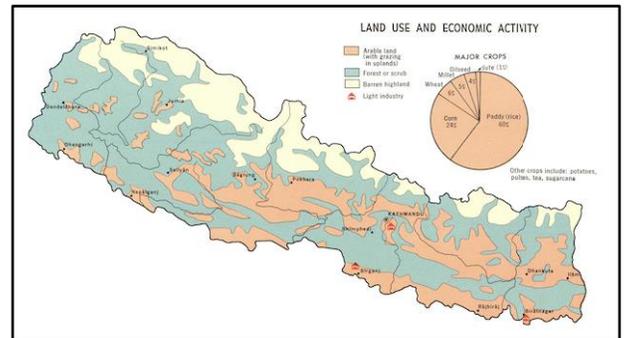


Figure 2. Nepal’s Land use Map (TEXAS, 1990)

In 2018, Nepal had 29.7 million inhabitants and an annual population growth rate of 1.09% (CIA, 2019). In 2011, 50.3% of the population resided in the Tarai zone, while in the mountain and hill zones were home for 6.7% and 43% of the population, respectively. In the mountain zone, the population growth rate was the lowest (0.54%) compared to the hill and Tarai zones at 1.06% and 1.72%, respectively. In the Tarai zone, 392 people live within one square kilometer and population density in the mountain zone is 34 people/ km²

(MoPE, 2017). Women outnumber men (51.3%). In terms of the age structure, there are five groups and the largest fraction of the population is in the 25-54 years age group (37.18%) and more than half of it are women (Figure 3). Meanwhile, in the group of 15-24 years, the total number of men and women are relatively the same (CIA, 2019). Migration, mortality, and, mostly, fertility affect the proportion of age structure (MoPE, 2017).

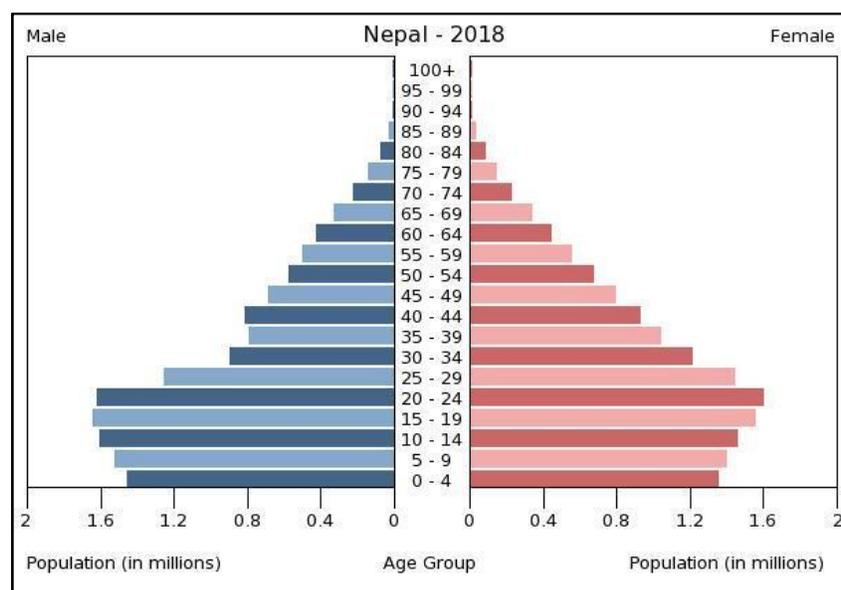


Figure 3. Nepalese population age structures by gender group (CIA, 2019)

Human development index (HDI) is measured by the three basic foundations of human development which are health, education, and living standard. In 2017, Nepal had an HDI of 0.574 categorized as medium human development category, which ranked Nepal in the 149th place out of 189 countries (UNDP, 2018). The local currency is Nepalese rupee (NPR). In 2017, Nepal was ranked 195th out of 228 countries based on its gross domestic product (GDP), which was approximately US\$2,700 per capita (CIA, 2019). In 2017, remittances contribution to GDP decreased to 28.31% from 31.29% in 2016 (UNDP, 2019). Despite long conflict and political instability, Nepal made progress in several areas. The number of people living below the national poverty line went down to 25.2%. Net school enrollment rate increased to 93.7% and gender parity was achieved in enrolment for primary education (FAO, 2014). However, around 22% of the total population still lack access to electricity while only 3% of the urban population live without electricity (CIA, 2019).

In the period between 2011-2017, 24.7% of the population were reported as skilled labor (UNDP, 2019), while 16.81 million people had serious lack of skills. The services sector may have the highest contribution to GDP (59.5%) among all sectors including agriculture (27% of GDP). But the agricultural sector derives the largest share of employment nationwide (69%). The industrial sector shares the smallest contribution of total GDP (13.5%) which it still relates to processing agricultural products such as sugarcane, tobacco, and grain. In 2017, Nepal was ranked 7th out of 202 countries on the growth rate of industrial production – approximately 12.4% – including manufacturing, mining, and construction (CIA, 2019).

The natural resource-based sector provides a source of investment, that includes, for instance, an estimated 42,000 Mega Watts of electricity generated from hydropower (CIA, 2019). In the period 2011-2017, exports and imports contributed to 51.8% of GDP (UNDP, 2019). India is the main trading partner for export

(53.1%) and import (70.2%); while the USA and China are each important for export and import, respectively. Exported products include clothing, carpets, and textiles. Imported products are petroleum, machinery, and electrical goods (CIA, 2019). In 2017, gross national income (GNI) per capita was US\$ 2,471 where women's and men's GNI were at 2,219 US\$ and 2,738 US\$, respectively (UNDP, 2019).

In 2017, average life expectancy at birth was 70.6 years and differed slightly between women and men (72.2 and 69 years, respectively). In 2015, the Government of Nepal (GoN) increased the health expenditure to 6.1% of GDP from 5.8% in 2014 mostly on healthcare goods and services. Health expenditure, which included for example infrastructure, information and technology, machinery, and stocks of vaccines for emergency or outbreaks, was not included in the capital health expenditure (UNDP, 2019). Currently, an improved drinking water system reaches more than 90% of the rural and urban population. In 2015, around 45.8% of the total population had access to improved sanitation facility such as sewer system or septic tank. In 2016, there was a high risk of waterborne – bacterial diarrhea – and vectorborne diseases such as malaria and dengue fever in the aftermath of the major earthquake of 2015 that led to poor sanitation and water contamination (CIA, 2019). However, public-private response and international aid helped mitigate the risk.

The literacy level of the population starting at age 15 and over who can read and write is 63.9% of the total population that corresponds to 76.4% of men and 53.1% of women (CIA, 2019). In 2017, total women and men at age 25 or older who finished and did not complete education at the secondary level were 27.3% and 43.1% of the total population, respectively (UNDP, 2019). This number contrasts with statistics from 2011 when the total number of boys and girls who dropped out of school was 34% and 35%, respectively. The main reasons for dropping out were economic problems for boys and marriage for girls (MoPE, 2017).

In 2017, total unemployment was 2.7% of the total labor force in the country, while 4.3% of youth at age 15-24 was also seeking paid employment or self-employment (UNDP, 2019). In the last 10 years, 47% of households have someone migrated to other countries such as the Middle East and India (USAID, 2017). Several sources suggest the government needs to pay attention to the unreported migration that affects the revenue generated from remittances, especially from neighboring countries, such as India (MoPE, 2017). Migration has different purposes: 80% of men leave for job purposes and almost 70% of women are to follow their husbands (USAID, 2017). People also move internally to other places in the country driven by resettlement programs from the Government, access to agricultural land, and better access to health, education, and transportation services. Most internal migration is influenced by relocation of people from the Hills and mountain zones to the Tarai area (MoPE, 2017).

Gender Equality and Social Inclusion (GESI)

In 2017 Nepal's Gender Development Index (GDI) value was 0.925 (defined as a ratio of the female to the male HDI, 0.552 vs 0.598 respectively). This was driven primarily by improvements in health (women achieved 72.2 years life expectancy at birth compared to 69 years among men) and education (12.6 expected years of schooling among female children vs 11.8 among male children), while the command over economic resources (estimated by female and male GNI per capita) remained low (\$2219 per women vs \$2738 per men, respectively (UNDP, 2018).

Gender Inequality Index (GII) still warrants improvement, ranking Nepal 118 out of 160 countries with the value of 0.480 in 2017. This was mainly due to political reforms to bring more women to parliament (29.6% of parliamentary seats are occupied by women) while women still lag behind men in other aspects of life, such as 27.3% of adult women have reached at least a secondary level of education vs. 43.1% of their male

counterparts, 258 women die from pregnancy related causes out of 100,000 live births, and the adolescent birth rate is 60.5 births per 1000 women of ages 15 to 19. Female participation in the labor market is high compared to other neighboring countries (e.g., Afghanistan) but lower than men's, 82.7% vs. 85.9%, respectively (UNDP, 2018).

The 2015 constitution of Nepal brought significant improvements to women's lives in Nepal. Specifically, Article 43 that deals with the rights of women, including rights to lineage, rights to safe maternity and reproduction, rights against all forms of exploitation, and rights in family matters and property. GoN prioritizes integrating gender equality into all development policies and programs and supports with a gender responsive budgeting system (UNDP, 2012). Another example of this is GoN's efforts in eliminating harmful practices among rural communities in Nepal, although they still occur (e.g., *chhaupadi*, a practice where women are forced to stay outside their home in cow sheds during menstruation and childbirth).

However, FAO's Country Gender Assessment report (2019) states that women still experience discrimination when it comes to access to education, labor market, health services, property, social security and freedom, as well as lower participation in decision-making processes at the household and community levels. The report further states that women in general but especially rural women face gender-based violence in both domestic and public spheres (e.g. physical violence, sexual exploitation, child or forced marriage).

In 2016, Nepal developed the GESI Strategy Framework to address gender inequalities, particularly in agriculture. The strategy targets "the most disadvantaged rural population, including lactating and pregnant women, indigenous and excluded communities, and people in disadvantaged regions" (FAO, 2019, p. 18). The Agriculture Development Strategy for 2015-2035 recognizes GESI as cross-cutting theme through the Strategy and appointed a 10-year Plan of Action to: "recognize female farmers' as independent farmers and ensure adequate budget provision for ... women's empowerment, including women's access to and control over productive resources, and women's leadership to empower rural women" (FAO, 2019, p. 18). The Plan calls for generating and maintaining GESI statistics, supporting GESI staff at central and district levels, providing women responsive agricultural extension services and promoting GEI-responsive agricultural research. There is also a provision in the Strategy that calls for land and capital support to marginalized groups (*Figure 4*).

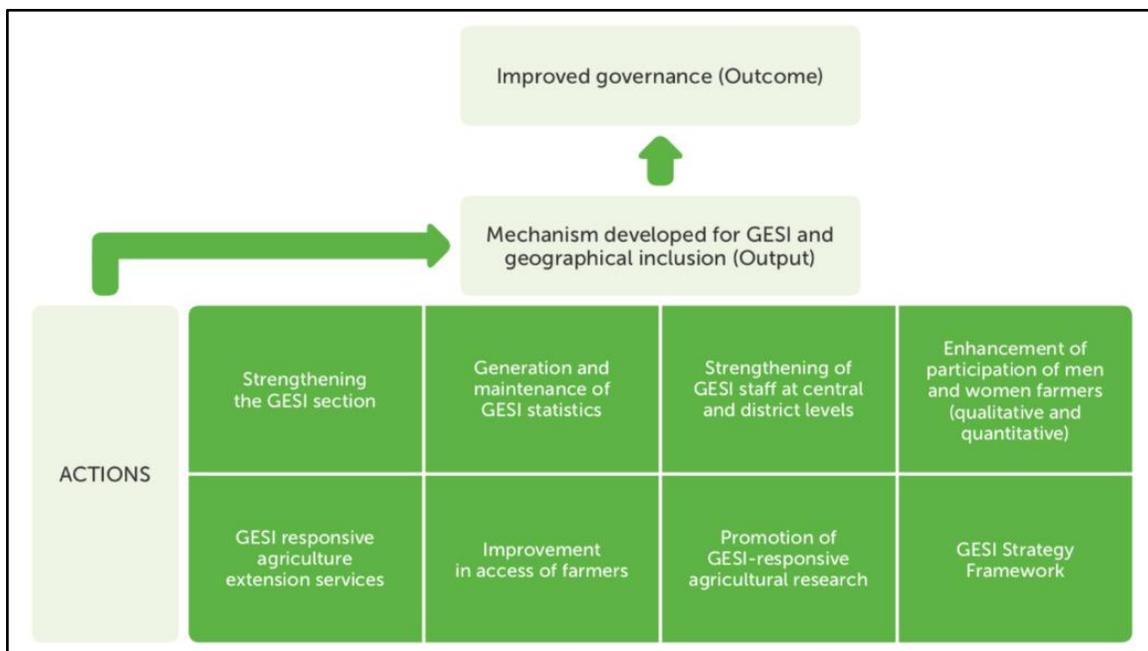


Figure 4. Conceptual framework for GESI mechanism in the Agriculture Development Strategy (FAO, 2019)

Livestock systems

Livestock activities are nationally regulated by the Ministry of Agriculture and Livestock Development (MoALD) (FAO, 2019). In rural areas, agriculture and livestock activities, on which more than 80% of the total rural population relies, are the main livelihood systems for communities and represents a key mechanism to curtail rural poverty that affects the socio-economic development of this population (MoLD, 2017). Despite the high percentage, the average size of agricultural land owned by households is less than one hectare per household, which is used to grow crops and raise livestock. The livestock sector contributes 11% to the national GDP (MoLD, 2017). The total number of livestock population in Nepal is divided into five groups: cattle and buffaloes; sheep and goats; poultry; pigs; and Yak/Nak/Chauri. Table 1 illustrates the total number of livestock population by animal species with goats and cattle representing the largest stock, 50% and 29% respectively.

Table 1: Livestock Statistics in Nepal by Animal Species

Livestock species	Number of Holdings	Number of Heads
Cattle	2,280,542	6,430,397
Buffalo	1,668,820	3,174,389
Sheep	98,464	612,884
Goats	2,463,253	11,225,130
Pig	477,984	880,197
Yak/Nak/Chauri	6,235	48,865
Total		22,371,862

Source: MoLD, 2017, p.3

Among 11.2 million of the total number of goats in Table 1 above, Province 3 and Province 1 have the most goat population (2,484,855 and 2,277,659, respectively). At the district level, the three highest goat pocket areas are located in Moran (329,800), Makwanpur (344,338), and Dhading (317,827) districts (MoLD, 2017).

Nepal also has a large flock of poultry, about 45.17 million in 2012, which is growing steadily (FAO, 2014). As cited in the FAO's poultry report (2014), 46% of poultry is of indigenous or local species scattered throughout the country, mostly in rural areas. Remaining 54% is under commercial poultry farm production situated primarily in large peri-urban areas (FAO, 2014).

Livestock characteristics and evolution

Livestock rearing is characterized by the country's three agro-ecological zones with different practices segregated further by regions (Gurung et al., 2005). The hills region is where more than half of cattle, buffalo, goats, and sheep are located, while the lowland plains in the Tarai region share only around 30% of the livestock kept. The cattle herd, with an annual growth of 0.39%, is more prominent in the lower hill region, while sheep, with an annual growth of 0.31% dominates in the Tarai zone (Upadhyay et al., 2017). Dairy has the highest portion in the sector – around 62.7% – followed by meat and eggs by 32.4% and 5%, respectively (FAO, 2004). Goat production supports around 70% of poor goat keepers in the hilly region (Khakural, 2003). The mid-western region of the country is the largest goat pocket areas for goat and sheep farming (Pandey & Shresta, 2018). An average household keeps around 3.3 goats per holding. Poultry activities are conducted through traditional farming and Kathmandu, Pokhara, and Chitwan valley are the center of the commercial poultry farming.

FAO's report (2005) highlighted the livestock sector as one of the keys for poverty reduction targets on the 2002-2007's Tenth Plan and a key driver of the broader agricultural sector on the 1997-2017's Agriculture Perspective Plan (APP). The study conducted by Upadhyay et al. (2017) reported that, during the implementation of the APP, the rates of livestock production increased – including livestock population, eggs, and milk production – except for meat production because cattle and buffalo are designated as mainly live animal exports (*Table 2*). In the agricultural trade, the livestock sector generates 4.85% of total export and 2.9% of total import. The study also explained that only goat production was stimulated compared to other livestock productions. As non-meat production and demand increased, the implementation of APP had diversified livestock keeping from large ruminant cattle to goat, chicken, and buffalo.

Livestock Production	Before APP 1975-1994			APP Period 1995-2014			Mean
	1975-1977	1992-1994	% change	1995-1997	2012-2014	% change	
Total Eggs (number)	282000.00	357037.00	26.61	384413.33	847335.00	120.42	214.11
Meat Total	105680.00	193023.67	82.65	211765.33	345488.67	63.15	246.58
Buffalo	35500.00	97656.67	175.09	107460.67	173817.33	61.75	435.10
Cattle	36635.00	42046.67	14.77	46920.00	51708.33	10.21	45.58
Chicken	4700.00	9201.67	95.78	9922.33	42096.33	324.26	837.67
Duck	45.00	268.67	497.04	287.00	220.33	-23.23	656.67
Goat	21500.00	30307.67	40.97	32499.33	56195.67	72.91	181.20
Pig	5000.00	10498.67	109.97	11733.67	18751.67	59.81	285.38
Sheep	2300.00	3043.67	32.33	2942.33	2699.00	-8.27	17.00
Milk, Total	721140.00	954139.00	32.31	1039782.67	1757982.33	69.07	150.83
Wool, greasy	580.00	620.00	6.90	622.33	2347.33	277.18	929.30

Table 2. Percentage change in livestock production for two periods (between 1975-1994 and 1995-2014) in Nepal (Upadhyay et al., 2017)

Animal trade and disease

Between 1990-2000 the trade in live animals reportedly doubled, especially for goat imports that came mainly from India (FAO, 2005). This increasing trend could have exacerbated disease transmission in cases when livestock trade was not controlled or managed properly. Besides the rinderpest virus that attacked large ruminants such as cattle, PPR still remains as the prevalent disease affecting sheep and goats despite the National PPR Control Program through vaccination (Kumar et al., 2014; Pandey & Shrestha, 2018).

There are four important diseases that affect livestock production in Nepal are classical swine fever, foot and mouth disease (FMD), Newcastle disease, and PPR (FAO, 2005). Some of the diseases, such as PPR, are preventable through the use of vaccines, which is considered one of the main tools for PPR control and eradication in countries where it is found endemic including Nepal (FAO, 2015). According to Pandey and Shrestha (2018), PPR outbreaks are common due to “excessive movements of nomadic herd of sheep and goats as per seasonal variation, common pasture, low vaccines coverage in mountain and hill regions due to geographic difficulty and low sero-conversion of vaccine.” (p. 45).

Livestock and gender

Sah and Shah (2016) point out to the high contribution of the livestock sector as a source of both nutrition and employment, the latter especially for women. The sector touches the equity issue where livestock keeping provides women an opportunity to contribute to the household's economy. The Agriculture Perspective Plan (APP) also emphasizes the livestock sector's role in enhancing rural women's participation in the agricultural labor force and development (APSC, 1995).

In general, lack of land ownership and access to veterinary services and livestock market are some of the main key factors that have remained as key obstacles for the rural poor's participation and benefitting from

livestock systems (Gurung et al., 2005). Often these barriers affect women more than men, as will be developed in more detail in the animal health, gender issues, and intersectionality subsection below. Because access to fixed assets, finances, and property are still lacking for women, that is, women seldom own land (MoPE, 2017), GALVmed (2011) emphasizes the importance of these actors as well as other marginalized groups in the success of livestock vaccination. Thus, formalization of women's land ownership and basic services in rural areas are recognized as national issues that remain to be fully addressed.

Animal health and veterinary services

Vaccines production and distribution

Vaccines availability at the Regional Vaccines Labs (also called banks) and stakeholder collaboration in the vaccine distribution system as well as the vaccination campaign monitoring and evaluation are the keys in the PPR Global Control and Eradication Strategy for Nepal (FAO, 2015). In Nepal, the Ministry of Agricultural Development provides veterinary services consisting of veterinary laboratories and vaccination. The system is organized at the national level (GARP, 2015) through collaboration with the provincial and local municipality levels, which are the result of recent decentralization efforts by the GoN to streamline resources to districts and to local hands. PPR vaccine is produced within the country by the National Vaccine Production Lab, located in Kathmandu. The production volume and distribution of PPR is managed by the National Disease Control Program for PPR.

The Government provides vaccines (and also pays vaccinators per vaccinated animal, five Nepali Rupees per animal) when disease outbreaks happen to prevent the expansion of the disease. The response is reactive rather than being proactive to stop disease occurrence through routine vaccination programs. DLS has been assigned to manage disease control where livestock diseases are still an important problem in the livestock sector. There is an established communication protocol where the local-level livestock services expert center inform the district-level or at times the provincial-level livestock service offices regarding the outbreaks or suspected cases of diseases through the report of a private veterinarian or livestock keeper. Then, the information passes to DLS at the national level, which then transfers the process of disease control to go back to the local level (see *Figure 5*). Vaccines for rinderpest, fowlpox, hemorrhagic septicemia, Newcastle disease, rabies, black quarter disease, anthrax, infectious bursal disease (Gumboro), swine fever and PPR are produced at the National Vaccine Production Lab under DLS (GARP, 2015).

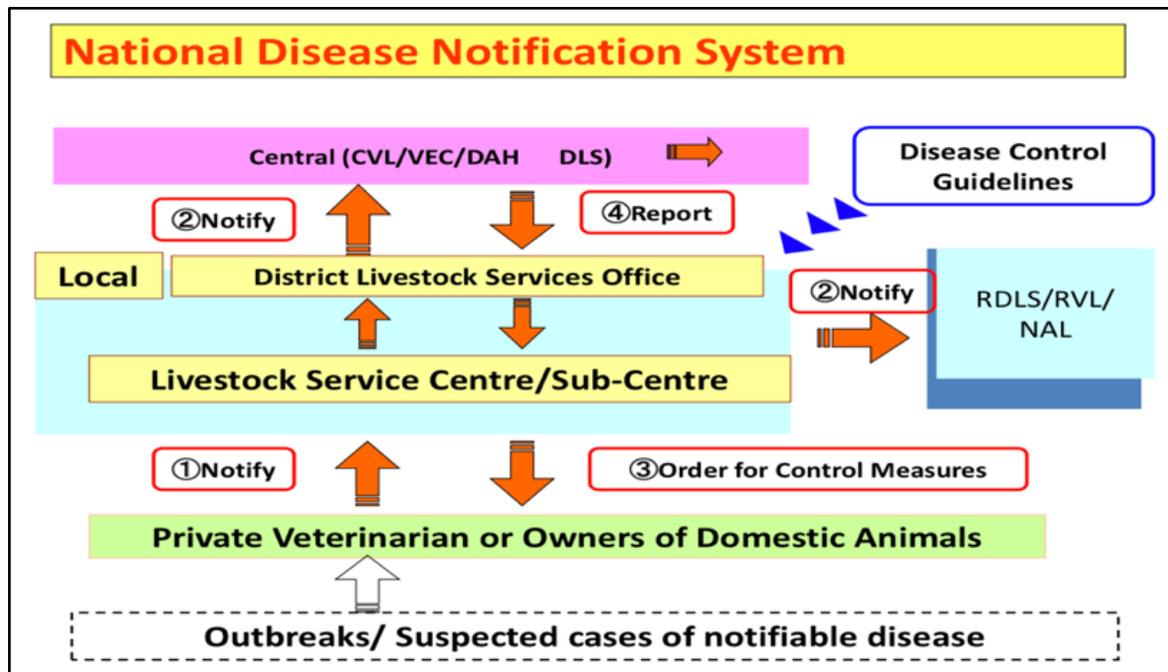


Figure 5. National disease notification system in Nepal (Thakur, 2014)

Animal veterinary services at different levels

The National Vaccine Production Lab is a national veterinary reference laboratory that is in charge of the investigation of epidemic and disease surveillance. This Lab operates through five regional veterinary laboratories (RVLs) – located in Biratnagar, Janakpur, Pokhara, Surkhet, and Dhangadi – and the National Avian Laboratory in Chitwan. At the district level, 15 basic laboratories in 15 district livestock service offices (DLSOs) and 60 primary laboratories have diagnostic facility (GARP, 2015).

Animal health service delivery systems layout animal related resources including knowledge and skills that are bound in an economic setting to provide services to both livestock keepers and animals (Mirajkar et al., 2011). The provision of services aims to enhance productivity by eliminating animal diseases, which will then could contribute to the increased well-being of the farmers.

In Nepal's veterinary service, there are several important actors at the community level: V/CAHWs, mid-level technicians including junior technicians (JTs) or junior technical assistants (JTAs), and veterinarians (VETs; Lamichhane and Shrestha, 2012). In places where veterinary services are available, livestock keepers choose to use the services based on the location as a function of the distance, livestock holding and capacity to pay as well as the quality of services (Mirajkar et al., 2011). For example, the services from V/CAHWs are more preferred because they are readily available when the services are needed and rural communities can often afford to pay for them (Stoufer et al., 2002). However, V/CAHWs have lack of formal animal health and management training, although the GoN instituted a 35-day CAHW training curricula, available in most provincial and district-level vet hospital (also called Livestock Services Expert Center). Noting the importance of veterinary services, it has been recommended that the Government together with the non-governmental organizations (NGOs) and private sector actors should enhance the capacity of veterinary workers and the integration to formal institutional structure at the district livestock service office (Lamichhane and Shrestha, 2012).

In isolated and less developed areas, animal health workers that are based in the community are more effective agents to support the dissemination of technology such as vaccines. These veterinary services at the local level are provided through CAHWs. A CAHW is an individual selected by the community and who receives a short training taking into account local priorities for basic services related to livestock-related issues including animal health (Catley and Leyland, 2002). CAHWs perceive vaccine availability and vaccination program as important factors to reduce the effect of livestock diseases. The active role of CAHWs can greatly influence the success of vaccination programs (Roeder et al., 2012). Reportedly, involvement of community members in the implementation and design as well as of private sector actors in the monitoring and vaccine supply contributed to the achievement of the CAHW system (Catley et al., 2004). Riviere-Cinnamond and Eregae (2003) highlighted a positive perception of CAHW's role by livestock keepers where they can access to medical and treatment services from CAHW. A study in Tanzania showed that a CAHW provided veterinary services and improved the surveillance of livestock diseases related to the coverage of spatial and temporal and administrative aspects including diseases reporting (Allport et al., 2005). In Nepal, V/CAHW's role extends to mitigating risks of natural disasters such as earthquakes that occur in areas that are difficult to access because V/CAHWs usually reach the marginalized and poor communities where external assistance such as service delivery is needed (Ratala, 2015). Thus, the V/CAHW is an important agent for the distribution of livestock vaccine, especially for vaccination programs (Roeder et al., 2012) because vaccine availability and accessibility support the implementation of the PPR eradication program (FAO, 2015). But there is little recognition of their role by the government including veterinary authorities including local or district veterinary officers. Thus, it is essential to understand to what extent the various roles are critical to disease control and provision of other services.

Goat vaccine and PPR control

PPR is an infectious disease caused by a virus that mostly affects small ruminants. It is considered endemic in most areas in sub-Saharan Africa, the Middle East, and South Asia (Munir, 2015; Parida et al., 2015; USDA, 2013). PPR represents severe risks to rural communities, especially socio-economic, in areas where small ruminants are the dominant livestock used both as a source of livelihood as well as nutrition (Mariner et al., 2016; Liu et al., 2014). As in the case with Rinderpest, PPR is a preventable disease using vaccines (Mariner et al., 2016) and PPR vaccines have been available and successfully adopted in many endemic areas (Parida et al., 2015). Liu et al. (2014) reported that Nigeria 75/1 is the first effective vaccine strain that stopped virus transmission without affecting animals. The next generation of attenuated vaccine strains produced Sungri 96, Arasur 87, and Coimbatore 97, all of which can be alternative vaccines for mass vaccination and improving immune to animals. The mechanism that allows for serological differentiation between infected and vaccinated animals (DIVA) is a new tool that enables to separate infected animals from vaccinated ones in order to effectively contribute to PPR eradication (Muniraju et al., 2015; Liu et al., 2014). As part of the PPR Global Control and Eradication Strategy, the mass vaccination and the vaccination campaign contributed and proved to eliminate PPR outbreaks in Somalia since 2012 and in Western Africa (FAO, 2015).

Libeau et al. (2014) explain that transmission of the virus can occur through feces and contaminated water, and/or through feed of infected animals. Because healthy and unhealthy animals are usually kept in the same spaces, the transmission rates are high. In the study conducted in two Nepalese districts (Shyangja and Tanahun) during a PPR outbreak in 1997/98 (August to September), PPR was the highest reported cause of goat mortality in Bandipur Municipality when the outbreak for the disease occurred (72 out of 215 reported cases). This outbreak was controlled by vaccines (Khakural, 2003). Diseases caused by other internal parasites were common, which affected goat production.

PPR control and eradication activities include assessment of first reports, aimed to understand the PPR status in the country and to determine the animal populations (FAO, 2015).

A further necessary trait required for a PPR vaccine to achieve eradication is thermostability or resistance to temperature changes. Thermo-sensitivity is a significant constraint of vaccine and improvements of PPR vaccine thermostability could contribute to achieve the immunization objective (Kumar et al., 2014). Karp et al. (2015) explain that improving the cold chain system promotes the effectiveness of a short-term vaccine coverage. In addition, a good information scheme on the delivery system contributes to reduced system costs that increases the efficiency of vaccination system. For PPR eradication, an integrated vaccination system takes into account the need for robust surveillance and epidemiological assessment, as well as understanding of the social impact of vaccine adoption, including coordination, and targeted vaccination (Mariner et al., 2016).

Goat vaccine value chain (VVC)

Department of Livestock Services is the key player in the goat VVC that formulates regulations and policies at the national level. Activities include the development of national plans, strategies, and programs that are implemented at the provincial and local levels. In terms of vaccines, DLS determines priorities of what, how many, and where vaccines will be distributed to the lower level. Together with researchers from the Nepal Agriculture Research Council (NARC), DLS investigates disease outbreaks at the ground level through collaboration with DLSOs. DLSOs coordinate with the local government to provide evidence-based data where information is collected by JTs, JTAs, V/CAHWs and goat cooperatives. See Figure 6 for schematic representation of goat VVC in Nepal.

The National Lab (sometime referred as a central vaccine lab, CVL), as stated earlier, produces and distributes livestock vaccines to RVLs. Through RVLs, livestock vaccines are disseminated to DLSOs and primary labs at the province level and then to vet hospitals at district level. The National Lab mainly follows the order of DLS in terms of the vaccine production. Because GoN has set target for mass vaccination program to eradicate livestock diseases, National Lab is the only responsible institution in charge of producing and distributing the vaccines, following orders by DLS.¹ The National Lab produced about 8 million doses of vaccine last year of which 7.5 million was distributed to livestock keepers through five provincial labs, and 500,000 doses were disseminated to agro-vet stores for commercial sale. The GoN-produced PPR vaccine is offered free of charge to livestock keepers. Goats are vaccinated once every three years. However, the majority of Nepali goats are for destined for meat and the life span of these goats is short (1.5 years) while breeder goats live longer. Therefore, the National Lab and veterinary services at all levels (national, provincial and local) recommend vaccinating animals yearly (Individual interview).

Besides the National Lab, Hester Biosciences Pvt. Ltd., a private vaccine producer and distributor from India, works in the country. Hester has authorization from the GoN to produce and distribute vaccines in the country. Hester's role in the LVVC is to support the GoN policies, programs, and targets to eradicate livestock diseases. Hester produces vaccines mainly for poultry. Hester also imports FMD vaccines from other countries, such as India, that are not yet produced in Nepal.

¹ Hester Biosciences has been producing PPR vaccine but for export purposes only. The large World Bank program on modernizing the livestock sector in Nepal is working with the GoN to allow the distribution of commercially available PPR vaccine produced by Hester (Individual interviews).

There are five RVLs that receive vaccines from CVL. From RVLs, vaccines are distributed to 15 DLSOs and 60 primary labs. The National Lab have fairly reasonable facilities that support the production of vaccines (author's personal visit to the lab). However, this condition varies at provincial and district levels. This relates to how vaccines are kept, which can affect the quality of vaccines and their effectiveness. Besides the facilities, remote locations of villages and geographic terrain, coupled with poor road infrastructure, affect vaccines' effectiveness, especially for livestock keepers who at time have to make long trips to district vet hospitals to request vaccines.

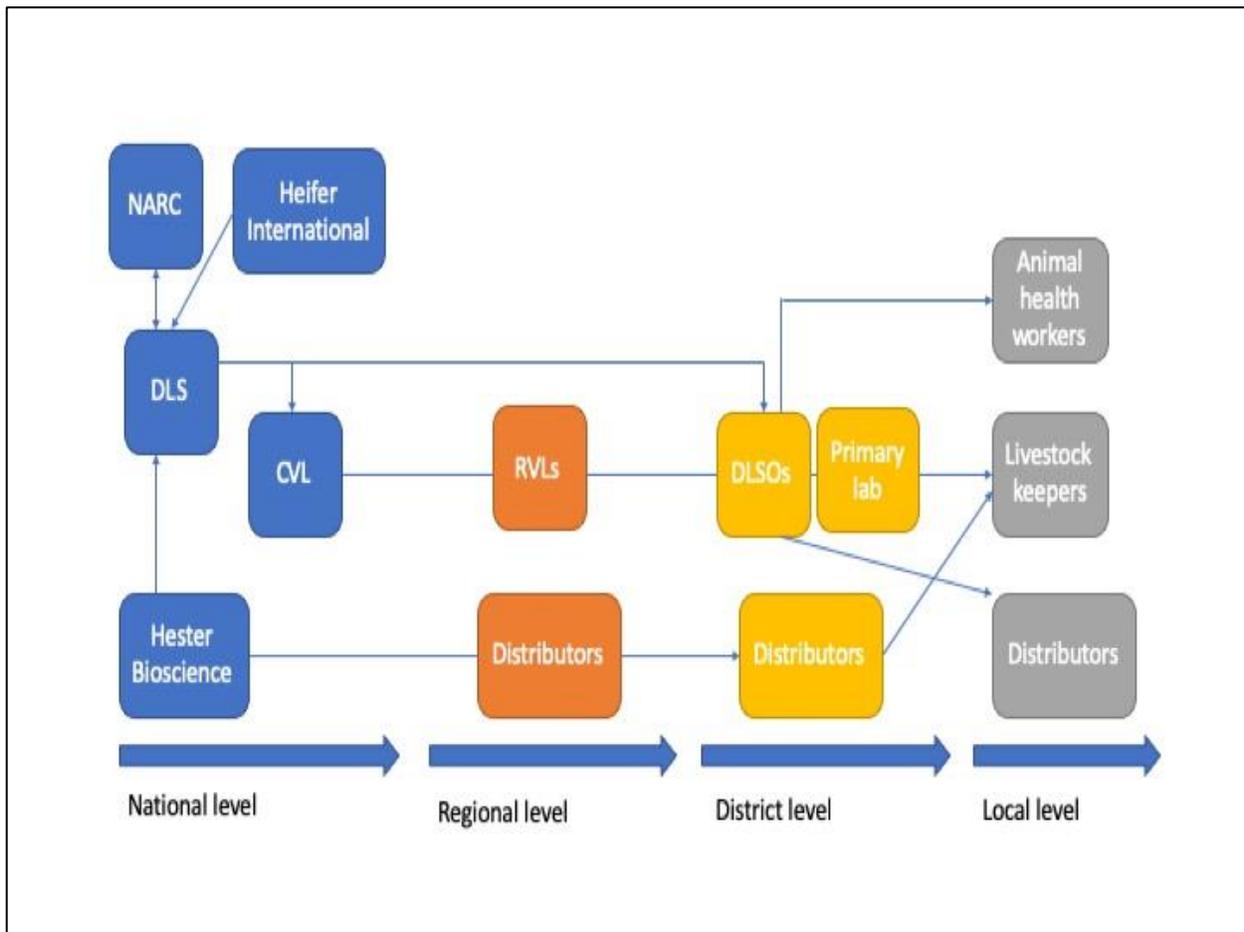


Figure 6. Schematic view of the livestock vaccine value chain (Author).

Animal health, gender issues, and intersectionality

In the agriculture production sector, 82.8% of women are asked by their family members to help with an activity while 76.4% of women are not paid. Although women are recognized as key individuals that support food security systems, they lack access to resources, services, and the labor market. With a high number of men migrating to follow labor opportunities, women bear the consequences since they then take responsibility for the entire household, including livestock keeping, requiring physical toll and time. Yet, because land ownership for women is lower than men, women's access to finance, technology, inputs, and government supports is limited, while men are mostly perceived to be the main beneficiaries (FAO, 2019). Paudel et al., (2009) noted that in Nepal, women own only 8% of the land and manage small ruminants. Men

are likely two-fold higher than women to own house and land. Although women’s contributions, especially through the provision of household labor, are high, women without control in the productive system are at a disadvantaged position in realizing the full benefits from activities in the livestock sector (Coles and Mitchell, 2011). This is further exacerbated by weak bargaining and decision-making power as well as limited market information. Due to socio-cultural factors, lack of women extension workers also contributes to the lack of knowledge among women about improved agricultural and livestock husbandry practices, as well technology dissemination. For instance, Muslim women in the Terai region are not allowed to meet outsiders, particularly men (FAO, 2019). Poverty in this region is higher in comparison to other regions nationwide (Rijal, n.d.).

Gurung et al. (2005) show that the livestock sector exists in the life of community where there are different groups according to wealth, sex, age, and castes at different levels. The study, however, acknowledges the power dynamics between men and women in the livestock management. Women have less power over assets and control over the production, where there are still many agricultural projects developed that favor men (Quisumbing et al., 2015). On one hand, there is a recognition of women’s role for managing livestock including knowledge, skills, and capabilities. On the other hand, women have limited access to market livestock sales and related important inputs such as access to vaccines or veterinary services which are at men’s domain (Gurung et al., 2005). Gurung et al. (2005) elaborate that, for example, poorer groups tend to have small animals such as goats, pigs, and poultry; while rich groups raise large livestock such as cattle or buffalo. The incidence of PPR, one of the main negative important factors, has a direct impact on the livelihoods of livestock-dependent communities, especially poor women (Libeau et al., 2014). Thus, PPR eradication will give women, who are responsible and most dependent on the benefits to have control over the production of small ruminants so they can partake in their family’s economic and nutrition as well as education for their children (FAO, 2015).

Paudel et al. (2009) note that in Nepal, livestock population per capita and per unit of cultivated land are one of the highest in Asia. Although women’s role in the productive system – particularly in household labor – is high, their participation in a cooperative system is low (Coles and Mitchell, 2011). Thus, it is important to promote agricultural and/or development programs that enable women to participate and to encourage women to partake in decision-making and other benefits (Figure 8; Paudel et al., 2009).

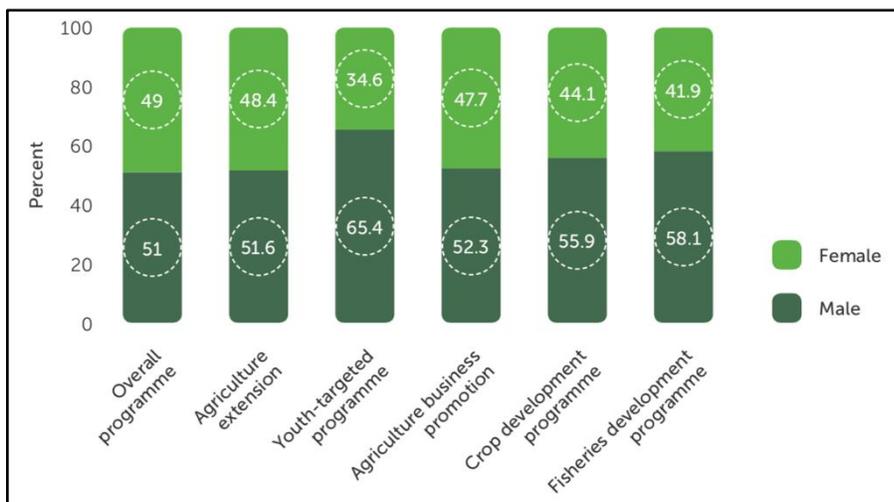


Figure 8. Share of men and women in agriculture development programs at the district level (FAO, 2019)

Intersectionality issues shaping the social norms and relations

In Nepal, the Hindu hierarchical system practice exists and shapes the society structure that systematically distinguish people based on caste, gender, and class. Dalit women, for example, have less access to economic sources in the community and less representation in the political and decision-making level of the State (OHCHR, 2012).

Women get married at an earlier age than men, but also women with no education marry even earlier than women with higher education (USAID, 2017). Traditional practices also put women at a disadvantaged condition. For example, child marriage is still prevalent in rural communities (USAID, 2017). At every level of education attended, men have a higher percentage compared to women (USAID, 2017). Education provision to girls seems undeniably beneficial, yet it is not perceived as such by parents. Education to women could increase family health (MoPE, 2017). Women who have jobs, earn less than men because 52% of women's work is unpaid and 77% of men receive a salary in cash. Men are likely two-fold higher than women to own a house and land. Despite increased participation in decision making, women have less voice to make a decision, especially at the household level (USAID, 2017).

Select organizations working in the livestock vaccine value chain

Ministry of Agricultural and Livestock Development (MoALD)

As the highest government institution, the ministry is in charge of the agricultural sector at the national level. Its objectives are to increase agricultural production and productivity while maintaining the environmental preservation. The ministry plays the central role in the formulation, implementation, monitoring, and evaluation of policies, programs, and strategies related to agriculture.

Department of Livestock Services (DLS)

DLS is in charge in animal husbandry sector in the Nepal's agricultural system. The main objective is to develop animal husbandry business as income generation and being recognized as a prestigious profession. In 2014, veterinary hospitals in 10 districts were established. As demand for animal health services increase, 33 veterinary hospitals, 21 dispensaries, and 18 checkpoints for the countrywide use of service were established by DLS with FAO/OXFAM support. To increase the coverage of the animal husbandry services, animal service offices, village level service centers, laboratories and (new) farms were established, gradually, in 75 districts. DLS determines priorities of what, how many, and where vaccines will be distributed to the lower level. Together with NARC, DLS investigates disease outbreaks at the ground level through collaboration with DLSOs. Moreover, DLSOs coordinate with the local government to provide evidence-based data where information is collected by community-level animal health workers and cooperatives.

Nepal Agricultural Research Council (NARC)

NARC was established in 1991 as an autonomous organization under "Nepal Agricultural Research Council Act – 1991" to conduct agricultural research in the country to uplift the economic level of the people. The objectives are to: 1) conduct qualitative studies and research projects on different aspects of agriculture; 2) identify existing problems in agriculture and find out solution to resolve them, and to 3) assist government in formulation of agricultural policies and strategies. One of the research areas is the livestock and animal health.

National Vaccine Production Lab

This lab is the only lab within the Government of Nepal. The Lab produces 13 different types of livestock vaccines for poultry, cattle, goats, swine, dogs, and cats. The lab was the first PPR producer in South East

Asia. Annual production is 40 million doses of vaccines including 8 million PPR vaccine doses. The lab has a level 3 biosecurity international certification, including a waste disposal plant, and facilities for testing highly hazardous pathogens.

Heifer International, an international NGO

The main focus of Heifer International is to contribute to the development of the goat value chain and then to the dairy value chain in Nepal. The goal is that, by 2023, Heifer Nepal will work to bring 500,000 families from a state of poverty and vulnerability to sustainability and resilience through their engagement in competitive, sustainable, and inclusive goat and dairy value chain enterprises for bringing economic growth, improved livelihoods and food and nutrition security. In 2007, Heifer Nepal had worked with 46 project partners benefiting over 15,000 families in 27 out of 75 districts. Heifer Nepal also introduced the country program strategy and investment plan in 2007 which focuses on livestock, improved technology, and technical training and education for knowledge and awareness. Heifer Nepal operate in many goat pocket areas of the country and helped establish the goat cooperatives which became critical hubs for market information exchange. Often cooperatives report the incidence of PPR disease in the area it operates in, and helps vaccinators gather goats at one location or inform community members about scheduled vaccinations.

Animal Health Training and Consultancy Service (AHTCS)

AHTCS was established in 2000 as a service-oriented, non-profit making NGO for improving the living standard of marginalized communities through partnership with national and international organization and agencies. It was started by the Animal Health Improvement Program (AHIP) of Rural Development Centre (RDC) under the direction of United Mission to Nepal in 1981 to address the myriad of constraints faced by rural livestock raisers. It is registered in District Administration Office Kaski and affiliated with the Social Welfare Council. It works for the benefit of its target communities in the areas of animal health, husbandry and equine welfare. It also addresses need-based livestock-mediated program diversification such as livelihood enhancement via agriculture practices. AHTCS trained many CAHWs using nationally approved 35-day CAHW curriculum.

Hester Biosciences Limited

Hester Biosciences Limited, founded in 1987, is one of India's leading animal healthcare companies and second largest poultry vaccine manufacturer. It has manufacturing facilities for products ranging from vaccines, health products to diagnostic tools. Its services include sero-profiling for poultry flocks and mastitis control programs for cattle. The four verticals: poultry vaccines, animal vaccines, poultry health products, and animal health products, together establish its identity as a strong animal healthcare company, addressing all sectors of animal healthcare. Its product portfolio includes over 50 vaccines and 35 health products. Hester produces PPR vaccine for export purpose only.

Provincial and district level veterinary services (Provincial Directorate of Livestock and Veterinary Services, Veterinary Hospital/Livestock Services Expert Center, Municipality Livestock Services Expert Centers): All together, these agencies help GoN to obtain information on recent PPR outbreaks and bring vaccines to the affected area. The Directorate of Livestock and Veterinary Services collects vaccine requests from veterinary hospitals and municipality livestock services expert centers and transmits information to the National Vaccine Lab through DLS. Once vaccines arrive in the provincial lab, the vaccines it distributed to vet hospitals and municipal livestock services expert centers. From there the

vaccines are dispatched to the communities, goat farms or goat cooperatives through JA, JTA, and V/CAHWs.

Livestock keepers: They are required to bring their animals to the vaccination sites. As stated earlier, GoN provides vaccines free of charge livestock keepers, and also pays vaccinators per vaccinated animal. However, during the field work, many livestock keepers complained that they still pay vaccinators to reimburse for transport and food because GoN support is not adequate, especially, when vaccinators have to travel long, remote and difficult terrain locations (Individual interviews).

Gap analysis identified for increasing women's engagement in and benefit from the LVVC

Many constraints hinder women's participation in the LVVC. Some are fundamentally challenging to tackle due to cultural barriers. Women face difficulty to control and access to the resource because men have power to make decisions at the household level (USAID, 2017). Efforts have been implemented by the Government to address gender-based issues that could improve equality for women to participate. However, those have not yet transpired into improved realities on the ground and require more support from the GoN (FAO, 2019). Their results may become an opportunity for women to enhance their active contribution in decision-making process and to fully receive benefits from the LVVC.

Women's role in the LVVC should be high taking into account their contribution in the livestock sector is prominent. Access of vaccines for women should be prioritized as they are in charge of livestock management, especially small ruminants (goats and sheep). Investments in facility and infrastructure improvements will enhance the adoption of vaccines as a mean to accommodate natural barriers such as scattered settlements and harsh environment, benefitting women as well.

Some of the limitations that hinder women's full involvement:

1. Lack of training for CAHWs and VAHWs

Veterinarians may not be motivated to work in areas that are difficult to reach taking into account safety and economic benefits (Catley et al., 2004). Animal health workers that are based in the community, such as V/CAHWs, are important vaccinators because they are ready to provide veterinary services when livestock keepers need. Providing basic training as animal health worker gives confidence and motivation to ensure the vaccination program success (Roeder et al., 2012). CAHWs can provide diagnoses and curative treatments for the sick animals to livestock keepers. But their capacity to diagnose diseases still needs to be enhanced considering the training is not conducted during the process of the development of CAHWs but at the final stage (Catley et al., 2004). The 35-day CAHW training should be offered on a continuous basis to increase the number of CAHWs and to share new information and disease management technologies with previously trained CAHWs. Moreover, a small portion of women are V/CAHWs in Nepal, thus limiting the reach of male V/CAHWs to households run by women when their significant others are in large cities or other countries.

2. Lack of recognition of V/CAHWs

Policies and legal regulations promoting animal health workers are lacking. Legislative reform becomes crucial to ensure the position of CAHWs in the veterinary services delivery system is recognized and supported by the government (Catley et al., 2004). Moreover, during fieldwork it was determined that V/CAHWs can be incorporated with existing producer cooperatives to give them recognition among livestock keepers. Having

animal services within a cooperative is also beneficial to cooperatives to boost their reputation being not only the bridge to market information but a facilitator of animal health.

3. Potential role of private sector actors

As the number of livestock increases, the number of animal health workers may not be sufficient to provide services. Collaboration between public and private actors would be crucial to help cover animal health services throughout the country (Mariner et al., 2012). Catley et al. (2004) report that CAHWs could be supervised by private veterinary firms and could improve the veterinary services delivery system because they have facility to distribute services. Similarly, to repeat the earlier comment about integrating CAHW services within cooperatives would be another way to improve animal health services.

4. Vaccine availability

Availability of vaccines is still the main problem at the community level. Transportation and storage remain big constraints, even when vaccines are freely provided. Roeder et al. (2012) point out the importance of designing incentive mechanisms for vaccinators to enhance their motivation to carry out their duty to ensure that the vaccines are maintained and delivered on time and in a good condition.

5. Access to vaccines

Accessibility of vaccines is also another issue where, due to geographic location, livestock keepers may not be able to access the vaccines that are available in the community. When vaccination programs are conducted in the center of a village, there is a slightly higher chance for smallholder livestock keepers who live in the outskirts of the village to bring animals for vaccination. When women are also in charge of children or live alone, this task may become impossible. Fieldwork in Nepal confirmed that lower caste families are located at the outskirts of villages and far from central roads making their access to vaccines difficult. It is unclear whether they are even kept in the loop when vaccines are available. In addition, the vaccinators target large stock of animals in one location rather than going house by house to vaccinate animals because the vaccines require proper equipment (cold box) for storage. Thus, it is difficult to reach all livestock, especially in hilly regions.

6. Lack of updated statistics on livestock

The GoN may set the goals and makes priority to eradicate the livestock diseases. However, data from the ground needs to be kept updated since the prioritization for vaccines is based on the data. CAHWs could service as a conduit to improve disease surveillance and control system (Catley et al., 2004). With proper training, they can contribute to improving data collection on outbreak presence and control.

7. Lack of awareness to curb disease spread

Understanding the importance of vaccines by the livestock keepers is also crucial. Even in situation where vaccines are available and accessible, disease control may not work if livestock keepers do not fully comprehend the value of the vaccines for their livestock.

8. Lengthy process in reporting

The lengthy process in information transfer and reporting from the local level to the national level could hinder the effectiveness of information and distribution systems. This also relates to the availability of human resources at the district and local levels of trained and sufficient personnel to make timely information delivery a priority.

Conclusions

Livestock vaccines are provided to livestock keepers free of charge by GoN, including PPR vaccine. Generally, the production of good quality vaccine is on par with the demand on the ground. Nonetheless, vaccines are delivered only during and after outbreaks, and due to various socio-economic and logistical considerations, vaccinators prioritize commercial goat farms or areas where goats can be gathered at one

location. One of the major challenges identified in the literature is the lack of adequate support to make vaccines available in adequate quantities and within an appropriate disease prevention and control scheme, i.e., proactive rather than reactive approach to vaccination would require a change in policy and practice. The other challenge is the lack of training and ill-equipped vaccination services at the local level, and poor infrastructure (roads).

These are also supported with observations and preliminary findings from mapping the LVVC. Cold chain maintenance systems are essential in the LVVC. Refrigerators and electricity are important components to store the vaccines. If the electricity is not stable, having power back up such as generators is also crucial. These facilities should be available down to the local level. Furthermore, the cold chain maintenance system is not only about the infrastructure and facilities. It is also important to understand how to maintain the effectiveness of the vaccines. Ensuring the actors have the capacity to apply the system will be a powerful force to improve the cold chain system. Distribution systems of the vaccines from producers to consumers have an impact on their effectiveness and efficiency. The roles of distributors and vaccinators are also important because they will support vaccine distribution that is available at the national level to reach the community throughout the country at critical times. Transportation facility and infrastructure affect the availability of vaccines in the community where the vaccination program occurs. Information systems about vaccines and vaccination are another important element and could facilitate timely response to outbreaks. Ensuring that all actors are aware of what to do and when will contribute to the success of program implementation so efforts should be made to educate local communities in areas where disease still seems to offer actual and potential risks. Assessment systems, once information is available, could help all agencies involved in disease control and eradication assess whether they are working in the most effective way and if not, to learn about mistakes so that they can improve the collective performance of the disease control system in the future. These systems will also help make positive results, such as increased in women's and other marginalized groups' participation and benefits from the LVVC, visible to those in the government promoting the GESI agenda.

Finally, the most important, involving women in the LVVC offers opportunities to have an effective management of the national PPR disease eradication program. At the local level, knowledge on the disease and vaccines will provide women a grounded understanding alongside with their daily practicality as the main actor in taking care of small ruminants. This will help them to value the importance of the disease and vaccine. Ease of access to the vaccine will support them to contribute actively to the success of the program. With the additional role played by women in child rearing, they can also educate future generations, starting at their homes, on the role of vaccines and best practices for livestock production.

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Appendix 1: Summary findings of gap analysis for increasing women's engagement in and benefit from the LVVC

Actors	Major Gaps in Knowledge	Vaccine Value Chain Gaps	Gender Gaps
Primary distributor (national) MoALD DLS National Vaccine Production Lab	<ul style="list-style-type: none"> Updated data on the disease occurrence and total livestock population Updated data on success of previous outbreak control campaigns Coordination within and across the institution at all levels Updated policy and regulation in the livestock sector under the new institution – MoALD Updated national livestock programs and strategies 	<ul style="list-style-type: none"> Areas priority by the Government to distribute vaccines Relationships or partnerships with private vaccine production company Lack of public-private participation Total control of vaccine production and distribution (e.g., PPR) 	Lack of women at the government level. Although women study in agricultural universities not all pursue careers in agriculture. Family oriented policies at the workplace (e.g., child-care)
<i>Note</i>		<ul style="list-style-type: none"> Administrative procedures to distribute vaccines Transportation networks 	
Secondary distributor (provincial) Provincial Directorate of Livestock and Veterinary Services Regional Vaccine Lab	<ul style="list-style-type: none"> Working areas coverage from the regional vaccine bank Proved systems to maintain the integrity and functionality of the vaccine Duplication of services (local/district/province chain) 	<ul style="list-style-type: none"> Facility and infrastructure in the regional vaccine bank Total number of staff 	Lack of professional women working at this level. Although women study in agricultural universities not all pursue careers in agriculture. Family oriented policies at the workplace (e.g., child-care)
<i>Note</i>		<ul style="list-style-type: none"> Transportation networks Coordination between government and private sector 	
Tertiary distributor (district) Veterinary Hospital/Livestock Services Expert Center, Municipality Livestock Services Expert Centers	<ul style="list-style-type: none"> Working areas coverage from the distributor Proved systems to maintain the integrity and functionality of the vaccine Duplication of services (local/district/province chain) Lack of continued training for JTs and JTAs 	<ul style="list-style-type: none"> Facility and infrastructure in the store Total number of technical staff Lack of coordination with private sector 	Many services are male-led; field-level technical staff (JTs and JTAs) are primarily men representing a barrier to access women-led households; Security and safety for female JTs and JTAs to travel long distance to access remote communities; cultural believes preventing women to work

<i>Node</i>		<ul style="list-style-type: none"> • Logistical constraints 	Lack of women in the LVVC as role models
V/CAHW or agro-vet store owners at community level	<ul style="list-style-type: none"> • Incentives for women to become CAHWs • Training needs • Locating CAHWs within producer or goats cooperatives 	<ul style="list-style-type: none"> • Role of CAHWs in the LVVC • Interaction of public and private spheres and their effect on female CAHWs 	<ul style="list-style-type: none"> • Number of women working as CAHWs or owning agro-vet stores • Integrating GESI at the community level • Application of GESI in LVVC
<i>Node</i>		<ul style="list-style-type: none"> • Transportation networks 	
Farmer/Pastoralist/Consumer	<ul style="list-style-type: none"> • Livestock systems • Updated data on livestock population • Improved animal health practices to prevent diseases 	<ul style="list-style-type: none"> • Knowledge on the disease, vaccines, and vaccination • Coordination among community and with the local government 	<ul style="list-style-type: none"> • Total woman headed family • Data on migration • Household and community power dynamics and their effects on female livestock keepers
<i>Node</i>		Social network and relations between LVVC nodes	Power-relations

Additional elaboration on gaps

Vaccine producer-level: The National Vaccine Production Lab is mandated to produce vaccines to supply the whole country to support the programs from the Government. DLS gives the instruction to the lab on how many vaccines need to produce and when to do so. The number of vaccines to produce is based on the available current data which is from the previous year outbreak reports. This means that there might be a gap in existing data collection since there might be an increase in the number of livestock and new disease outbreaks.

The Lab delivers vaccines to regional vaccines banks. In theory, the regional vaccines bank should have the same facility to store vaccines to maintain effectiveness/quality of vaccines. More work is needed to explore if current vaccination storage at provincial-level vaccine labs meet national standards for vaccine quality upkeep. Finally, it is important to know transportation from Kathmandu affects vaccine effectiveness.

Besides the lab, there are also two private companies that produce vaccines. In theory, the companies will support the government program to supply vaccines. The companies should fully align their business work with the government plan and revise it accordingly in a periodic manner. However, the extent or mechanisms of coordination between these companies and the government are not yet clear. There are certain vaccines, such as PPR, that are produced only by the National Lab. Given porous borders with India, it is important to find out if illegal PPR vaccines come across from India despite GoN control of the area.

Distributor: The regional vaccine bank delivers vaccines to districts designated by DLS. DLS decides how many and what kind of vaccines to be distributed. In theory, the distributors at the district level have a sufficient facility to store vaccines. Their role is important as they are the stakeholder that provides vaccines to livestock keepers at the local level. However, many studies mention lack of capacity at the district level. This means that the quality of the vaccines may not be as good as when these are produced in the lab.

In the delivery system, transportation networks are also important. Infrastructure influences how good quality vaccines will be delivered to the community on time. With challenging geographic characteristics that limit

access to livestock keepers, we do not know how distributors can ensure the distribution of vaccines to the community on time while maintaining the quality.

Consumer: The government has a national animal disease eradication program, especially, targeting designated areas where the vaccination is free. The vaccination is conducted in the center of the village. Farmers will bring their animals to the vaccination spot in the community. With the limitation of facility, vaccines will be kept in a cool box to maintain the temperature. This system may affect the quality of vaccines if the vaccinator does not pay attention to the temperature. Another limitation is that for farmers to bring their animals to the vaccination spot can be challenging, because the houses might be spread and located far from the center. This causes some farmers – male or female, but also elderly, disabled, poorer, lower caste, etc. - to be unable to physically take their animals when vaccination takes place. With a limited knowledge about the importance of vaccines and vaccination, and limited CAHW support, these farmers are unlikely to come to the center, especially, when they are poor smallholder farmers, especially women torn between different responsibilities at the household level to accommodate vaccination times.