

Research Article

Milk Production and Value Chain in Rural Area of Nepal: A Case from Gandaki River Basin

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Abstract

Livestock husbandry is directly linked to food security and is considered one of the most crucial components of the agriculture system. As an agrarian economy, livestock farming is the backbone of Nepal's food security and agriculture system. The government of Nepal is concentrating its efforts to increase milk production and marketing through livestock farmers to uplift their livelihoods. Several authors have studied milk production and its value chain effects on farmers. However, there are very limited studies involving milk cooperatives in the Gandaki River Basin of Nepal. The paper aims to analyze the existing status of milk production and milk products value chain in Chanauli of Chitwan, Dumre of Tanahun and Palungtar of Gorkha districts in Gandaki River Basin of Nepal. Both descriptive and exploratory research design was done where both qualitative and quantitative information was gathered. Simple random sampling was used. The farmers providing at least 10 liters of milk production in the cooperatives were selected for the study purpose. Further, they also provided information on livestock feeding materials and preferences. During the study, the in-depth assessment was carried out on milk and milk products marketing through identified actors and their relationships. The results of the study revealed that buffaloes alone contributed about 84% of the milk production in the Gandaki River Basin. The milk production, butter conversion from milk,

market sell, and quantity of milk differ by season, quality of fodder availability, and type of breed of livestock. The key actors in the formal dairy value system included milk producer farmers, milk-producing cooperatives, milk collection cooperatives, and milk processing plants/cheese factories. Further, milk and milk products were channeled to consumers through both formal and informal marketing systems through private and dairy development cooperatives. The results give insight for policy-shaping for seasonal and sustainable milk and milk-products production which could support the livelihood of the rural communities. The result would be a reference for livestock husbandry for milk production in similar socio-economic settings.

Keywords: Dairy; Fodder tree; Milk cooperative; Milk product; Value chain

Introduction

Livestock husbandry is directly linked to food security and is considered one of the most crucial components of the agriculture system. As an agrarian economy, livestock farming is the backbone of Nepal's food security and agriculture system. The government of Nepal is concentrating its efforts to increase milk production and marketing through livestock farmers to uplift their livelihoods. Economically, Nepal is based on agriculture where livestock farming is the backbone of the system. Physiographically, it is divided into five regions: High Himal, High Mountain, Middle Mountain, Churia, and Terai [1]. Hydrologically, it has four basins (Koshi, Gandaki, Karnali and Mahakali). Within such circumstances, the government is focusing its efforts through policy and plan to raise agriculture products including milk and milk products [2,3]. Agroforestry and private forestry have become a supportive sector to supply fodders in milk production and livestock development [3-5]. Milk production is the regular activity in Nepal which holds cash/money from the urban which creates self-employment within the farm family and employment to the milk sellers both within the rural and concrete area.

Dairy is a promising sector for providing significant opportunities for livelihood management in Nepal. Some researchers have found that the production of 100 liters of milk within the geographic region can create full-time employment within the country [6]. Production of milk, as a dairy sub-sector, contributes income and nutritious food particularly for vulnerable groups of individuals like children, pregnant women, elderly and helps within the rural food security [7]. It shares around one-third of the Agricultural Gross Domestic Product (AGDP) and contributes almost two-thirds (63%) within the livestock GDP in Nepal. In Nepal, over 100,000 farm households are involved in the dairy business and quite 1750 Primary Milk Producers' Cooperatives (PMPCs) are engaged in delivering milk from rural to urban areas in Nepal [8]. The dairy sector is gradually emerging as a commercial/ semi-commercial enterprise particularly within the semi-urban and all geographical regions of the country [7]. Cattle and Buffaloes are the main dairy species for milk production within the country. Despite the larger cattle population, the buffalo contributes around 71% of the annual milk production and only 26% by cattle [9].

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The fodder trees come in association with dairy products as they are the major source of nurturing the livestock in the region. There are more than a dozen indigenous and common fodder trees found as agroforestry species in these regions [10]. To increase milk production, there is always pressure on fodder availability. Several authors have developed some technology that recommended that fodder seedlings can be raised through vegetative propagation or cuttings [11], which may help to propagate without allowing the fodder tree to good seed production.

Animal husbandry is a traditional practice in the country in which dairy production solely depends on. A report from UK AID mentioned that among the 3.8 million farming households in the country, 95% have dairy animals because of the key role they play in household subsistence and nutrition, the provision of draft power, and local transport. Most households produce mainly for home consumption with some flush season sales. Only about 14% of milk-producing households (i.e. 500,000) are both producers and sellers [12]. There are 7.3 million cattle, 5.1 million buffaloes, 0.8 million sheep, 10.1 million goats, 1.2 million pigs, 68 million poultry, and 0.3 million ducks in the country. Out of the total bovine population, only 15% of cattle and 36% of buffaloes are estimated to be crossbred animals [13]. This scenario gives an idea about the conservation of the local gene-pool of local breeds of livestock in this region is further interesting. Moreover, exploring the situation in Gandaki River Basin (GRB) would be further interesting to see the existing situation of dairy production and value chain together with the status of agro-biodiversity conservation as the population of livestock is in increasing trend in this region [9].

Milk production in GRB is engaged from the smallholder farmers. However, a minor portion of the locally produced milk enters the commercial sector attributable to the marketing constraints and lack of processing techniques suitable for smallholder dairying. To sustain milk production to satisfy the increasing demand, efforts to extend milk production should go hand in hand with efforts and knowledge to dispose of milk surpluses above local requirements within the milk-producing villages. The livestock production within the selected areas of GRB viz. Chitwan, Tanahun and Gorkha support an estimated 10% of the population and covers 50-60% of the full area of the region [6]. Despite the importance of the milk chain within the contribution of the rural economy, the prevailing situation of the milk value chain within the line to rural development is poorly documented. Therefore, the study was through with the target to explore the matter associated with the milk value chain to contribute to boosting the livelihood of the agricultural communities within the GRB of Nepal.

Methodology

Both descriptive and exploratory research design was applied to study the milk value chain in the three districts of the GRB namely; Gorkha at Palungtar, Middle Mountains region, Tanahun at Dulegaunda, Middle Mountains and Chitawan at Chanauli, Inner Terai region of Nepal. The main reason for selecting these is that cattle and buffalo farming are important as a source of milk production in this area. Additionally, these areas occupy the central part of the country, cover about 40% of the country's livestock population. Also, these areas are densely populated rural as well as urban settings in which with the existing road infrastructure, the milk and its products could easily transport to different urban centers like Pokhara, Damauli, Narayangadh and other urban centers through private companies or organized communities after value addition.

Primary data were collected from a total of 90 individual farmers, 30 farmers from each research site. The farmers were selected from Buffalo/Cattle raising groups of the research sites. The farmers providing at least 10 liters or more milk to the cooperatives were selected. The study was based on both qualitative and quantitative nature of data. Quantitative information has been supported by qualitative information and vice versa. Data sources were of two types; viz. primary and secondary. A field survey was the basic source of the primary data. Data were collected from field surveys, personal interviews, case studies, and focus group discussions. Interviews were conducted using a structured questionnaire. Information was collected from cattle/buffalo keeping farmers, milk collection centers, milk chilling centers, milk processing factories, milk distributing booth consumers, and agro-vets in the research sites. The respondents were also asked to explore the status of fodder trees and livestock feeding materials and their preferences.

To collect primary data, tools were the structured questionnaire, semi or unstructured interview and observation methods were used. Data was collected using the Participatory Rural Appraisal (PRA) technique. There were both open-end and close-end questions included. The questions included in the questionnaire tried to attempt the things especially, the existing pattern of livestock and milk production, milk value chain, the role of key intermediates, and the constraints and opportunities were tried to obtain as well. Secondary source of data on the dairy status of the country was collected from the Central Bureau of Statistics, Babarmahal, Kathmandu, Nepal, between 2013 and 2019 [14,15]. The milk production, collection, transportation, processing, and selling data were obtained from government, milk cooperatives, Dairy Development Company, private dairy from research sites in and around GRB.

Results and Discussion

Livestock profile

There are approximately 5.5 million cattle, buffaloes, sheep, and goats accounted for by national census and estimated from in 2019 field survey in the Gandaki River Basin (Table 1).

Species	2013	2019
Cattle	1,445,717	75,570
Buffalo	1,453,577	80,501
Goat	2,012,376	2,12,120
Sheep	1,74,383	3,221

Table 1: Major livestock in Gandaki River Basin in 2013 and 2019 [15,16].

The raising of livestock always has been largely a subsistence activity. The Cattle in GRB is almost entirely of the zebu type (a species or subspecies of domestic cattle originating in South Asia) and are sources of milk and meat. However, these cattle do relatively well under the normal production system. Meat and milk yields are low and losses are high, especially among calves and young stock. Contagious diseases and parasitic infections are major causes of death. Recurring drought could be a factor for the loss of giant livestock resource that influences the animal population, although it's difficult to work out the extent of losses. Table 2 shows the existing key livestock population gathered from a household survey in the study sites during this study in 2015.

Practically, all animals are range-fed despite the propagation of fodder trees in their private land. During the rainy seasons, water and

Name of the Sites	Cattle	Buffalo
Chitwan	51	67
Gorkha	24	69
Tanahun	8	60
Sheep	1,74,383	3,221

Table 2: Cattle and buffo heads in the study sites.

grass are generally plentiful, but with the onset of the time of year, forage is mostly insufficient in the Basin. Despite the existing enormous livestock resource and great potential for increased livestock production, productivity is disproportional. The results are seen lower due to various livestock management problems, such as the prevalence of major endemic diseases, poor feeding, and high stocking rate on grazing lands. Lack of support services such as extension services, insufficient data with which to plan improved services, and inadequate information on how to improve animal breeding, marketing, and processing also critically affects the production. The supply of livestock feeding material is an important component of livestock husbandry and milk production in Nepal. Some commonly found indigenous fodder trees are listed in table 3 with the preferences of farmers.

Milk production and product market

Three major milk and milk products markets were identified. These are Dumre, Damauli and Narayangadh. On average, a complete of 6150 liters of milk center the current market per day from these markets. Up to 1500 liters of milk used to supply in season and go up to 4600 liters of milk during the wet season. Out of the full milk supplied to the local gathering center, 2592 liter (15%) is transported to the cities from the study area.

Intensive dairy farming and milk production

Most of the intensive dairy farms are concentrated in and around these areas are based on crossbred stock. The urban, semi-urban, and intensive dairy farmers produce 2% of the total milk production of the country. The system mostly runs with crossbred animals more than 20 heads feed on improved pastures, hays and supplemental agro-industrial feeds. In the GRB, the state dairy farms were declined in their management due to inefficiencies in production. There is a downwards trend in milk yields and herd performance. Both the herd size and the total number of cows have been on a declining trend suggesting an acute shortfall of replacement herd and supply of breeding stock to smallholder farmers. The main feeds sources are agro-industrial by-products (oilseed cakes, Bran) and purchased roughage. Farmers use all or part of their land for homegrown feeds. Generally, the primary objective of the production system is to sell milk as a means of additional cash income. The system is characterized by small scale intensive husbandry with crossbreeds not more than 10 heads and managed under zero-grazing - full stall feeding.

Quantity of milk production

The quantity that uses the regular cash income to buy household necessities or to save for festival occasions [17]. Both the commercial and smallholder farmers produce 98% of the country's milk production [18]. The quantity of milk produced in the study area provides the basic outlines on milk consumption/ day and market availability. To estimate the total milk production in the area the following parameters were used: livestock population, female and lactating animal's

proportion in the herd size, length of the lactation period, and milk yield per day per animal.

Out of the total population in these areas, the mature female animals kept for milk production are identified. It is found to be 38.42% and of these, about 60% assumed is milk-producing animals annually [14]. Besides this proportion, the productivity of milk i.e. milk liter/animal/day identified from the study litters and 2.5 litters and an estimated average of 1.5 litters/cattle.

The lactation length also ranges between 120 to 305 days based on the availability of feed and water as well as the length of dry seasons and an average of 270 days is considered. Milk production and productivity are affected by the seasons of the year. There is more milk is produced with high productivity (liter/animal) (March, April, and May) and short rainy season called (September and October) and productivity fluctuates over season and years. Seasonal variability of milk production in these areas is managed by the amount and distribution of rainfall, and availability of forages cum fodder and water. Based on these events milk production is fluctuated in the four seasons of the year and from year to year container.

Household consumption and market availability

The semi-commercial and commercial farmers of these zones have been doing traditional milk processing practices at the household level and produce butter, skimmed milk, yogurt. They produce milk products like butter to cope with the problem of the short shelf life of fresh milk. This is because fresh milk will not stay fresh in some areas even until they reach the market hence they are forced to process it to butter to cope with the risk of perishables. The study revealed that the more the farmers are far from the market they tend to process the milk and produce butter. Moreover the higher the wealth (livestock) the farmers have, the higher will be the intensity and size of milk processed and changed into different milk products.

According to the focus group discussions with the farmers and women milk processing cooperatives, the proportion of the skimmed milk production from the whole milk is ranged from 70% to 80 % with an average of 75% where yogurt production is on average estimated to about 25% of the total processed whole milk values. It was also learned that 1 kg of butter was produced from 8-12 liters of whole milk (depending on the season- in the wet season takes 12 liters and in dry season 8 liters). Hence on the average of 10 litters, whole milk is considered to produce 1 kg of butter. Above all, it is apparent that the proportion of the butter product per unit of whole milk varies based on the breed type, parity, milking management, and feed types.

Milk is one of the most important livestock products. It is the main diet for farmers. Milk production from milking animals (cattle, buffalo) is influenced by their population and distribution, and the availability of natural pasture and water. Besides, types of animal breeds and the composition of milking animals in the herd are one of the most important factors influencing milk production in the production system. The milk production also directly correlated with the environmental situation. The better the environment/climate the better is the milk production and vice versa. The milk-producing animals (cattle, buffalo) in all studied areas are indigenous and crossbreed. Cattle are well recognized in their dual purposes production and hardiness. Moreover, the study identified that during the prolonged dry season and drought hazard, milking cows move further away to take advantage of grazing and water sources. The animals milking frequency

Name of the Sites	Physiographic region	Local Name	Scientific Name
Chitwan	Inner Terai	Badahar (P) Sissoo Siris Khanyu (P)	<i>Artocarpus lakoocha</i> <i>Dalbergia sissoo</i> <i>Albezia species</i> <i>Ficus semicordata</i>
Gorkha	Mid hills	Tanki /Koiralo (P) Rai khanyu (P) Phaledo (P) Kutmiro (P) Kabro (P)	<i>Bahunia species</i> <i>Ficus semicordata</i> <i>Erthrinaa rborea</i> <i>Litsea monopetala</i> <i>Ficus lacor</i>
Tanahun	Mid hills	Badahar (P) Sissoo Siris Khanyu (P) Tanki /Koiralo (P) Rai khanyu (P) Phaledo (P) Kutmiro (P) Kabro (P) Dudhilo (P) Nimaro Kimbu (P)	<i>Artocarpus lakoocha</i> <i>Dalbergia sissoo</i> <i>Albezia species</i> <i>Ficus semicordata</i> <i>Bahunia</i> <i>Ficus semicordata</i> <i>Erthrina arborea</i> <i>Litsea monopetala</i> <i>Ficus lacor</i> <i>Ficus nimoralis</i> <i>Ficus roxburghii</i> <i>Morus alba</i>

Table 3: Physiographic region and fodder trees.

P: Preference

per day varies based on the type of livestock species and seasonal calendars of the year. In the wet season, where forage and water are relatively available, lactating cows are milked twice a day early in the morning before grazing time and in the evening after grazing. Traditional cows that lost their calf due to death will not be milked even though they can supply milk. On the other hand, during prolonged dry periods where feed and water are highly scarce, the cattle are milked only once or none.

Research and Technology

In the long run, there is always a need for research and availability of technology for the effective and efficient production of milk and milk products. However, there is still inadequate support and innovation for research and extension in livestock and dairy technology to increase milk production and decrease the cost of production. Despite the efforts of the governments, the market and value chain of milk production is yet to be exploited.

Investment and feeding materials

To increase milk production and fulfill the demand of the people, the investment of the government is a vital aspect. Furthermore, farmers in the area are also seeking facilities such as insurance and soft loans to individual farmers or on a cluster basis. Long term planning for adequate fund flow to develop infrastructures like a cold store, laboratory, veterinary facilities, and milk diversification is urged. Further, the voices of farmers also focused on feeding material to increase milk production. There is still lacking proper attention to enhance livestock feeding material through conservation of pasture and rangeland and seedling production of fodder trees through seeds and cuttings. There is also the potential to produce fodder trees through vegetative methods or propagation by cuttings.

SWOT analysis of the dairy sector

There are different levels of strength, weaknesses, opportunities, and threats recognize in the dairy sector of GRB. The research synthesized the following strength, weakness, opportunity, and threats.

Strength

The strength of the dairy sector has been developed in rural areas. Some encouraging areas to be proud of being strong dairy cooperatives with their presence from the grass-root level i.e. rural area to the central level. They have become a strong channel between the rural milk producers and the milk processing industries. In the sub-sector, keeping animals is a household practice and people are passionate about animal keeping. Besides, there is increasing involvement of NGOs and the private sector in livestock development activities in a rural area, particularly in providing technical support services and veterinary health care, employment (full or part-time) for thousand of households (formal and informal sector), stable and daily source of income.

Weaknesses

Hygienic milk production and lack of stringent measures on quality control are key weaknesses in the sub-sector. Further, there is a lack of awareness, scattered production, and difficult geography- increased cost in collection and transportation. Also, poor infrastructure for milk collection, chilling, and transport is insufficient. There is still an inadequate support system to encourage farmers to increase livestock feeding material through conservation of pasture and rangeland and seedling production of fodder trees through seeds and cuttings. Moreover, relatively little progress has been made in research and expansion of livestock and dairy technologies to improve milk production and reduce production costs. The government has not focused on ensuring security through insurance and soft loan to farmers- individual or cluster. Farmer's friendly investment modality is still lacking to develop infrastructures like a cold store, laboratory, veterinary facilities, and milk diversification.

Opportunities

The milk and milk products value chain have opportunities due to widely distributed livestock, distribution of cattle and buffaloes, market opportunities of milk and milk products increased (urban areas), the involvement of private sector in dairy business increased with the

establishment of new dairy industries and cheese factories. Further opportunities are the growth of tourism which increased demand for modern dairy products, dairy cooperatives from the grass-root level to the central level. Also, there is a strong channel between the rural milk producers and the milk processing industries which can be accounted as an opportunity in the sub-sector.

Threats

The compulsion for coexistence is threats to milk and milk production. Major threats included productive and unproductive (old, male, diseased) cattle further depleting scarce feeding resources, poor competitiveness- an upsurge in import of milk and milk products, open and uncontrolled border with India. Additional threats include increasing cost of inputs including labor, shortage of labor- young generation seeking jobs overseas, reluctance of financial institutions on lending for agriculture, high opportunity costs of land and labor particularly around the main highways and townships where the dairy farming activities are mostly carried out, emerging diseases of zoonotic and economic significance. Similarly, other threats included raising awareness on carbon trade among 43 people has resulted in increasing closure of community forests (which are presently the main source of fuel wood and fodder to the community in any parts of the country). These pragmatic threats of the milk-producing areas in the GRB. Moreover, the market and value chain of milk production is not much satisfactory (2013 and 2019) [14,15] hence to be exploited to uplift the farmer's livelihoods in the GRB which could be a milestone to the country.

Conclusion and Way Forward

The study revealed that buffaloes alone contribute about 84% of the milk production in the Gandaki River Basin. The key actors in the formal dairy value system included milk producer farmers & cooperatives, and milk processing plants/cheese factories. Further, milk and milk products were channeled to consumers through both formal and informal marketing systems through private and Dairy Development Cooperative businesses. Additionally, some relevant information like milk availability, seasonal milk availability, a system of production, milk product diversifications were obtained during the study in the GRB. The price of milk gets added when its by-product gets diversified. There is a high potential for milk sources in the districts of GRB's and should be exploited fully.

Few recommendations are made base on the study analyses. Promote livestock feeding material through conservation of pasture and rangeland and seedling production of fodder trees through seeds and cuttings is required. Ensure security through insurance and soft loan to farmers- individual or cluster should be promoted. Invest adequate funds to develop infrastructures like a cold store, laboratory, veterinary facilities, and milk diversification are key for dairy promotion. Needs further research and extension in livestock and dairy technology to increase milk production and decrease the cost of production.

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Author's Contribution

The first author conceptualized the research, involved in necessary data collection, data analyzed, and write up the first manuscript. The

second and third authors thoroughly wrote up the introduction and discussions part including whole document editing and supervised. The remaining authors thoroughly checked the whole manuscript, reviewed and edited the whole document, English edited, coherency checked. All the authors have approved the final version of the manuscript and agreed on submission for publication.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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