Strengths, Weaknesses, Opportunities and Threats of Pasturelands in Terai Region of Nepal

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Journal of Livestock Science (ISSN online 2277-6214) 15: 86-94
Received on 29/12/23; Accepted on 5/3/24; Published on 15/3/24
doi. 10.33259/JLivestSci.2024.86-94

Abstracts

The livestock sector plays a vital role in the national economy, providing a source of food, income, and employment in Nepal. For ruminants, the important issue is to improve nutritional value and hence utilization of existing feed stuffs. Fodder cultivation and pasture improvement is a relatively new concept for Nepalese farmers in Nepal. To improve poor feeding system focus should be given on year round forage production system. The term "pasturelands" refers to lands where the native vegetation is primarily made up of grasses, grass-like plants, forbs, or shrubs. Pasturelands are managed as a natural ecosystem that offers ecosystem goods (food, forage, timber, pharmaceuticals, and fuels) as well as ecosystem services (air and water purification, droughts and flood mitigation, detoxification and waste decomposition, preservation of biodiversity and soil fertility, pollination, etc.). Here, strengths, weeknesses, opportunities and threats of pasturelands in Terai region of Nepal are assessed. The strengths that can be developed are knowledge and know-how of the farmer, genetic qualities of the pastures and interest in quality pastures on the market. The weaknesses that can be changed in desired direction are weak relationship with science, low-yielding pastures, lacking of an organized marketing system and danger of infectious diseases. These weaknesses can be overcome by improving the relation with science, leading to a positive development of a number of opportunities such as improving knowledge on ruminant nutrition and on pastures, improving the quality of pastures and development of branded marketing structures and regulations guaranteeing the production and trade of high quality pastures. The most substantial threats for the pasturelands in Terai, which can lead to risks for its development, are lack of pastures, decrease in market prices, high feed prices and spread of infectious diseases. When planning the project activities, the focus should be on the overcoming the weaknesses (W). Also the project activities must be aimed at reducing the risk of threats (T) and developing the opportunities (O). The correct determining of the project activities and the correct organization of the appropriate target groups in its implementation can support the development of the pasturelands in Terai region of Nepal.

Keywords: Forage production system; Livestock; Nutritional value; Pasture improvement

Introduction

Nepal is an agricultural country geographically divided into three distinct agro-ecological zones which are Mountains, Hills and Terai (*Nepal Population (2020) - Worldometer*, n.d.). The economy of Nepal is agricultural dependent as two third of the population is engaged in agriculture. Agriculture denotes typical combination of crops, livestock and forests under integrated mixed farming system. Livestock have traditionally played an important and multi-purpose role in Nepalese agriculture (FAO, 2015). Around 87 percent of households in Nepal keep some form of livestock. Livestock farming is the important economically supporting business in Nepal. It was started from ancient times though commercial farming has been started recently. Livestock is mostly reared for milk and drought purposes, which approximately contributes about 25.68% of AGDP (MoAD, 2015). The livestock sector is a principal source of food and employment being one of the fastest-growing agricultural sub-sectors, which provides livelihoods for around 1.3 billion people and accounts for around 40% of the global agricultural gross domestic product (AGDP) (Steinfeld et al., 2006). The livestock sector is expected to become even more crucial as it has to offer 60 percent more output globally to meet the growing demand and the expected dietary changes of the over nine billion people who will exist by 2050 (FAO, 2009). For this, the livestock sector will play a vital role in fulfilling a growing demand for animal-derived foods while ensuring future global food security (Herrero et al., 2009).

In Nepal, there are reported to be 7.4 million cattle, 5.1 million buffaloes and 0.048 million yak/Chauries, 13.99 million goats, 0.77 million sheep, 1.5 million pigs, 0.056 million equines, 66.80 million fowl and 0.60 million ducks as presented in Table 1 (MoALD, 2022). Among Livestock, cattle and buffaloes contribute about 63% of the total livestock. There are only 3000 cattle farms and 424 buffalo farms which are registered commercial farms of Nepal. In dairy production, cattle contribute two third and buffaloes contribute one third of total milk production in farms. The country produces 1.9 million liters milk per day whereas the demand per day is 2.4 million liters so importing from India to fulfill the demand. This study suggests the scope of cattle farming in Nepal. The milk production of a livestock is limited between 500 to 2000 liters per year. The low productivity is due to lack of pure breeds, low access to veterinarians and AI technology, governmental policies, feed management problems and management problems of non-productive cattle, etc (DDC, 2013).

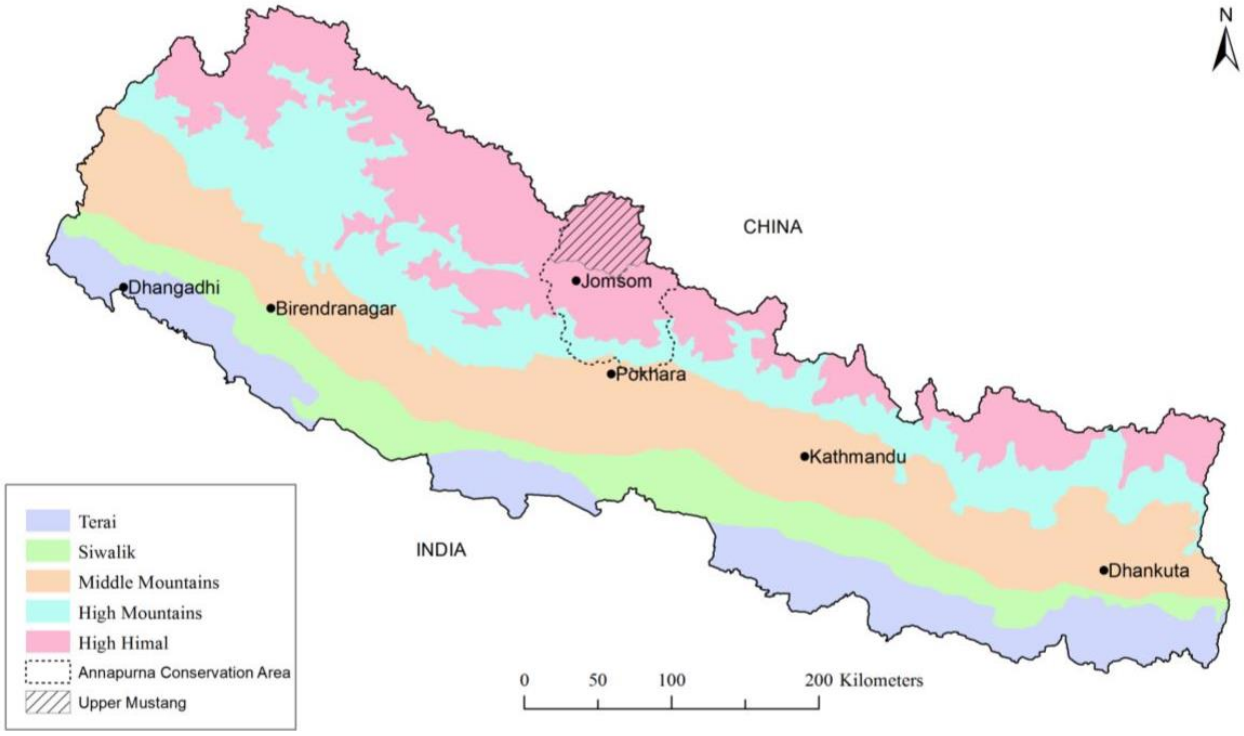

Fig 1 Geographical division of Nepal based on Agro-ecological zone

Table 1 Livestock Population in 2021/2022 (MoALD, 2022)

Animal Category	Population (2021/22)	Average Annual Growth rate*
Cattle	7413197	0.28%
Buffaloes	5132931	2.26%
Sheep	771205	-0.05%
Goat	13990703	3.77%
Pigs	1504624	2.81%
Fowl	66803117	15.98%
Duck	605944	-0.06%
Milking cow	1223061	1.84%
Milking Buffaloes	1666827	2.66%
Laying hen	10131642	4.43%
Laying duck	302473	-041%

*Average Annual Population Growth rate is calculated using last ten-year data

Table 2 TDN requirements by Eco-zone (Singh & Singh, 2019)

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

Table 3 Total area and Pastureland area under Various Physiographic regions

Physiographic region	Total land area		Pastureland		
	Ha (Millions)	%	Ha (Thousands)	% of total land	% of Pasture land
Terai	2.1	14.4	49.7	0.3	2.9
Siwaliks	1.9	12.7	206	0.1	12
Middle Mountains	4.4	29.5	292.8	2.0	17.2
High Mountains	2.9	19.7	507.1	3.4	29.8
High Himalayas	3.5	23.7	831.5	5.6	48.9
Total	14.8	100	1701.7	11.4	100

Table 4 Pastureland category based on Physiographic regions and altitude of Nepal

Physiographic Region	Pastureland Types	Altitude (masl)
Terai	Tropical Pastureland	1000
Siwalik	Sub-Tropical Pastureland	1000-2000
Middle Mountain	Temperate Pastureland	2000-3000
High Mountain	Sub-Alpine Pastureland	3000-4000
High Himalayas	Alpine Pastureland	4000-5000
Trans-Himalayas	Steppe Zones	2000-5000

One of the major problems is feed management. Outdoor grazing is limited to only 10% commercial farms due to lack of good grazing pastures. Commercially, different feed companies produced concentrate mass and palate feed which increases the milk production and reduces the profit (Pant et al., 2020). The big cattle farms in Nepal use both concentrate feed and forage in equal ratio. Feed is generally provided twice a day and supplied 0.5 kg concentrates per liter of milk and remaining feed is given as fodder and hay. While the ruminants and equines

depend mostly on feeds available on private and common property resources, the rural poultry and pigs depend on scavenging, and the commercial stocks on concentrate feed mixes. The feed deficit was estimated to be about 30.9% in terms of Total Digestible Nutrients (TDN) during the 1980's (Rajbhandary & Shah, 1981). No systematic studies have taken place since then. Customarily, the national planners use the one-third feed deficit figure even today. However, there have been significant changes in land use pattern, livestock population and production and the farming system in Nepal since then.

Total TDN demand of livestock was reported to be 12.257 million tons according to Table 2. This demand is 1.3 times higher than 9.461 million tons as reported during 1990s (Rajbhandari & Pradhan, 1991). The large ruminants occupied about 83% of total TDN requirements in the country. The share of cattle was the highest followed by buffalo among the large ruminants. The share of small ruminants was only 6.6%, of which goat occupied 94% and the rest by sheep. Pig and poultry each occupied below 5% of total demand. TDN requirements in the mid-hills was the highest (47.6%) followed by the Terai (43.6%), and the high-hills (8.8%) as per Table 2. Cattle population was the major consumer of feeds across the eco-zone, followed by buffalo and for total volume of milk production.

The land use pattern in Nepal show that there is about 1.7 million hectors of grassland, 3.9 million hectors of agricultural lands, 4.3 million hectors forest and 1.6 million hectors of shrub lands and degraded forests. The ruminant such as cattle and buffalo are kept on grazing, and /or crop residue in both Terai and hills of the country (Gautam et al 2021). Districts in Terai have 40 percent of their total land used for cultivation because of its plain landform and high fertility of soil there (LRMP, 1979). On the contrary, only 4.4 percent of the total land is used for cultivation in the Mountain region. The rugged terrain, altitude and steep slope are the main limiting factors. The hill region occupies an intermediate position in the proportion of cultivated land as it is situated in between two extremes. There is also an east-west variation in this proportion. Districts located in the east have higher proportion of cultivated land and the proportion gradually decreases towards west. This applies to all ecological zones (Subedi, 2001). Since Terai covers most of the total area for cultivation, livestock based development need to be focused on the Terai area as it can be the strong means of livelihood support.

Pasturelands are lands on which the indigenous vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and are managed as a natural ecosystem which provides environmental and economic benefits/ecosystem goods like food, forage, timber, pharmaceuticals and fuels whereas ecosystem services such as purification of air and water, flood and drought mitigation, detoxification and decomposition of wastes, biodiversity and soil fertility conserve, pollination, pest control, nutrient cycling, climate stabilization, aesthetic beauty and intellectual stimulation (Miller, 1997). Although, Land use/land cover change is to be the main challenges of pasturelands and decrease its size as the world including in Nepal. Pasturelands have been converted to other land use/land cover due increasing population pressure, illegal fire, agricultural land expansion, deforestation and property right issue. Land use/land cover change is affecting the pasturelands biodiversity like decrease plants and animals' diversity with their productivities, minimize ecosystem services and goods which are provides by pasturelands, decrease soil fertility of pasturelands because upper layer of the land is susceptible to erosion. The main reason of this entire phenomenon is removal of vegetation coverage in the pasturelands area. Land-use change is not only affecting pasturelands biodiversity, it is one of the driving forces for climate change and the major environmental problems too.

SWOT analysis is one of the strategic techniques for analysis of a specific business situation, which assesses the strengths and weaknesses, as well as opportunities and threats associated with business development or project planning. The main purpose is to reveal the opportunities and eliminate the dangers with realization of successful strategy to achieve the goal (David, 2009). In different countries around the world SWOT analysis is used to describe the possibilities and identify the dangers for achieving the goals in pasturelands in Terai region, optimizing strategies for implementing certain activities that contribute to achieving these goals.

SWOT Matrix

The strengths that can be further developed are knowledge and know-how of the farmer, genetic qualities of the pastures and interest in quality pastures on the market. The weaknesses that can be changed in desired direction are weak relationship with science, low-yielding pastures, lack of an organized marketing system and danger of infectious diseases. These weaknesses can be overcome by improving the relation with science, leading to a positive development of a number of opportunities such as improving knowledge on ruminant nutrition and on pastures, improving the quality of pastures and development of branded marketing structures and regulations guaranteeing the production and trade of high quality pastures. The most substantial threats for the pasturelands in Terai, which can lead to risks for its development, are lack of pastures, decrease in market prices, high feed prices and spread of infectious diseases. When planning the project activities, the focus should be on the overcoming the

weaknesses (W). Also the project activities must be aimed at reducing the risk of threats (T) and developing the opportunities (O). In the SWOT matrix scheme, the four cells represent the four possible alternative strategies SO, WO, ST and WT. The analysis and summarizing so far show that the weaknesses (W) and the threats (T) for the business prevail at almost equal value to the opportunities (O). This means to carry out actions that lead to minimizing weaknesses thus limiting risks to the sector and to support the realization of opportunities. The correct determining of the project activities and the correct organization of the appropriate target groups in its implementation can support the development of the pasturelands in Terai region of Nepal.

	Strengths (S) Derived from the Internal Factor Matrix	Weaknesses (W) Derived from the Internal factor Matrix
Opportunities (O) Derived from the External Factor Matrix	SO Strategies Develops strategies that use the strengths of the studied business	WO Strategies Develops strategies that minimize the weaknesses of the studied business to provide an advantage in a particular area
Threats (T) Derived from the External Factor Matrix	ST Strategies Develops strategies that use the strengths of the studied business to deal with the threats	WT Strategies Develops strategies that minimize the weaknesses of the studied business in dealing with threats

Fig 2 Schematic illustration of a SWOT matrix (David, 2009)

Discussion

Pastureland is one of the natural resources in which livestock farming mainly relies on. The size of pastureland is declining due to the shift from pastureland classification to urban infrastructure, mining, and agriculture, flood damage, and sand movement (Enkh-Amgalan, 2013). Pastureland can provide important services for herders and livestock owners (Gómez-Miranda et al 2021). Livestock supports the livelihoods of more than 1 billion people, including the world's poorest, and in context to Nepal, the livestock sector plays an important role in GDP (MoLD, 2017). At the same time, overgrazing caused by livestock has played a key role in degrading ecosystems, deforestation, and increasing demand for fodder crops. On the other hand, ecosystem degradation adversely affects long-term sustainable livestock production and productivity.

Strengths of Pasturelands in Terai

Nepal has diversified types of climate. The climate ranges from tropical in the Terai region to the alpine in the high Himalayas. Within the region itself as in case of Terai itself, there is a variation of micro climates and the climate and geographical area is favorable for establishmanet of pastureland. The germplasm introduced in Nepal have wider ranges of species. Among the introduced species, some are annual and some are perennial. Furthermore, depending on the growing season these species are divided as summer and winter forage. Based on the available information suitable species for Terai regions are listed which are its strength (Pande, 1993).

In Terai, good irrigation can be provided more easily in comparison to hilly and mountain zone ensuring good cultivation of pastureland in Terai region than other agro-ecological zones. To maintain current livestock numbers and to reduce grazing and browsing impacts on forest enterprises, alternative forages must be developed on private and public pasture land. Grass and legume seedings in agroforestry projects on crop and forestland and seedings in marginal croplands have the potential to improve the forage resource. Improved control over season, intensity, frequency, and duration of grazing would substantially improve productivity of existing as well as seeded grasses and legumes (George, 1995). This makes them an essential resource for both maintaining environmental services like biodiversity conservation and as a source of livelihood, especially for rural communities (Asner, Gregory, Andrew, Lydia, & Roberta, 2004). Pasturelands are used primarily as a source of feed for livestock as it is liked by the grazing animals. They provide other secondary resources such as firewood, wild foods, medicinal plants and water.

Weaknesses of Pasturelands in Terai

Pasturelands in Terai regions are lost due to changes in land use system like dramatic expansion of farming practices, establishment of private and government ranches, the rapid infestation of bush plant species and a major facilitator with climate change impact (Garedew, 2010). Many studies have been done about effects of land use and

land cover change on a pasturelands biodiversity but its degradation has been continued until present due to land use/landcover change in a country. These shows as there are a gap of awareness in community and lack of scientific land use planning policy (Grumbine, 1994). Similarly both cool season annual and perennial grasses and legumes are prevalent but they are subjected to uncontrolled grazing. Some of the weaknesses that can be observed in the pastureland of Terai region are:

- Prioritizing concentrate feed
- Insufficient institutional support
- Lack of fertilizer to establish legume forages
- Low yielding pastures
- Shortage of feed/fodder during winter
- Lack of land for forage cultivation and pasture establishment
- Lack of appropriate technology(variety, methods, production system)
- Lack of forage seeds
- Lack of a sustainable technology and related support system
- Lack of methods for hay making and other ways of forage conservation
- Lack of identification and promotion of native species
- Lack of forage distribution in remote pastoral areas
- Poor genetic characteristics of livestock
- Limited organized market for pasture produced

Opportunities of Pasturelands in Terai

The major limiting factor for the development of fodder and pasture production in Nepal is the availability of quality seed. Till now majority of required seed are imported from overseas. However, seed production of fodder crop such as oat, berseem are quite popular and has shown potentiality to export to the neighbouring country since the last decades. For example, during 1990, 500 kgs of oat seed and 300 kgs of berseem seed have already been exported to Bangladesh by Department of Livestock Services (Pande, 1993). Similarly, perennial pasture species like stylo and molasses grass have shown great potentiality for seed production. Thus there seems a good potentiality to promote pasture and fodder seed production in Nepal. The study conducted on fodder seed production has revealed that different regions are suitable to produce different species of fodder and pasture seeds. The recorded seed yield from different species/cultivars at different sites of Terai regions are presented in Table 6.

Table 5 Suitable Grasses and legumes for Terai Ecological zones (Pande, 1993)

Season	Legumes	Non-Legumes
Summer	Centurian, Lablab, Disc Medic, *Glycine*, Cowpea, Common vetch	*Teosinte*, Bajra, Sudan, Maize, Marval grass
Winter	Berseem, Shaftal, Senjii, Fenugreek, Sainfoin, Lupin	Oat, Maize
Perennial	Centro, Siratro, Desmodium, Stylo, Kudzu, *Glycine*, Centurian	Napier, *Setaria*, Molasses, Signal, Dinanath grass

Table 6 Seed production from different species/cultivars at different sites (Pande, 1993)

Species Cultivar	**Seed yield (kg/ha)**	**Site**
Avena sativa Kent	1250	Janakpur
Sorghum bicolar	99.7	Gaughat
Pennisetum americanum	2840	Gaughat
Lupinus angustifolius	800	Janakpur

Some of the exotic species have ability to produce large quanitity fodder of higher quality even under harsh conditions. The most promising species in terms of dry matter production and seed production are found to be:

- Legumes: berseem, vetch, stylo, white clove
- Grasses: oat, teosinte, napier, molasses, perennial ryegrass, cocksfoot

The productivity of these grasses and legumes are recorded up to 18 times more than the native grasses (Pande, 1994). Similarly, given the small landholding and shortage of feeds, particularly, during the winter and dry summer,

there is a need of promoting double or triple fodder cropping systems for increased nutrient production per unit of land area which can be a huge scope for pasturelands. Likewise since pastoralists rear all types of livestock such as cattle, buffalo, and goats in the Terai, they can also grow crops (sorghum and maize) in parallel with animal rearing and can have a good earning as Agropastoralists (Ellis & Swift, 1988). Other opportunities that can be utilized from pasturelands can also be:

- Improving knowledge on ruminants nutrition
- Improving knowledge on the botanical composition of pastures
- Improving the relationship with science
- Creation and development of branded marketing structures and regulations guaranteeing the production and trade of pastures
- Potential for improving the quality of pastures
- Improving knowledge on integration with the environment
- Growing interest from investors

Threats of Pasturelands in Terai

Agricultural lands have been expanded at the expense of natural forests to meet the additional food demands for the increasing population (Gibbs et al., 2010). It is becoming increasingly clear that the ecological balance of pastures is being disturbed due to unregulated pasture use. Pasture degradation is associated with frequent natural phenomena such as droughts and the proliferation of voles, as well as overgrazing in certain areas, abnormal herd structure, and human activities such as wildfires (Bakei & Purev, 2019). However, it is growing concern that most of such pasturelands are degrading day by day mainly due to high stocking density, and poor management. It has been estimated that the dry mater productivity of pasturelands in general is only 2.5 t/ha/year, which is unmatchable in terms of carrying capacity and need of animal's requirements associated with high stocking rates (Meshesha et al., 2019). This emphasizes need to introduce sound and sustainable range management system in the Terai region.

Selective feeders as well as the uncontrolled over grazing results in the suppression and loss of the preferred species, creating a less productive vegetative composition which then is covered by the unwanted species, such as *Eupatorium adenophorum* and *Lantana camara*. Forest browsing may eventually inhibit the tree growth resulting ageing and thinning. Trampling caused due to livestock results in compaction of soil and degradation in soil structure. It also affects to the water infiltration and thus increased in runoff. Similarly, hill cattle trails also concentrate run-off water and greatly increase the hazard of sheet and gully erosion. Likewise, Forage collection, litter collection, fire and destruction of predators may be the consequence of grazing. Grazing might lower absolute numbers of animals. Species substitution might be occurs due to change in prevalence forages. For example, there could be increased in buffalo numbers at the expense of cattle. The situation might result in change from large ruminants to small ruminants.Changes in grazing pattern might reduce the number of animals, for example for draft purpose (LMP, 1990). The threats which can be assessed in pasturelands in Terai are:

- Decrease in market value of pasturelands
- High seed prices(fodder seed)
- Spread of infectious diseases
- Higher competition between countries on the international market
- Difficult access to working capital (loans)
- Unmanaged urbanization

Conclusion

Nepal depends heavily on the livestock sector for the source of food, income, and employment needs. Improving nutritional content and consequently feed consumption for ruminants is a key concern. For Nepalese farmers, fodder farming and pasture development are relatively new ideas. Focus should be placed on a year-round forage production system to enhance the feeding system. Through the study, the strengths and weaknesses for the development of the pasturelands in Terai of Nepal (internal factors), as well as the opportunities and threats (external factors), were assessed. The analysis of the SWOT matrix points at WT and WO strategies, which are the implemented actions leading to minimization of weaknesses to limit the threats for the sector, as well as to support the realization of opportunities. Based on this challenge different ideas have been provided as recommendation to improve those challenges

- Government should be creating awareness to societies as they will not change a pastureland to crop land or other uses and to enhance land planning policy

- Peoples should be gives emphasis to animal rearing rather than crop production and wood extraction on pastureland area.

Acknowledgement
The authors are thankful to Agriculture and Forestry University for providing opportunity.

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