Impacts of Climate Change on Pastoral System: A Study on Tibetan Plateau, World's Third Pole

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Abstract: Tibet's vast grasslands are not only a grazing land, but it is prime ecological importance for their great biodiversity and as another nature is upper catchments of most of Asia's main rivers (water tower of Asia). This unique region has been continuously used for transhumant grazing by sheep, goats, and yaks. During the last 60 years, climate change has been fall the effects on the pastoral system and the management of these plateau area's rangelands have undergone major shifts from feudalism to collectivism to the privatization of livestock with individual grazing rights. When the development of industry was collectivized and modern health care for man and beast introduced, both animal populations rose extremely steeply, human and overgrazing became widespread and the fragile grasslands suffered and their yield dropped. In this paper, to quantify the plateau area's grazing land and livestock production system and showing the transformational of the pastoral system due to the effect of climate change and finally, suggested the scope for exploring opportunities for sustainable development of pastoral systems.

Keywords: Pastoralism; Animal Production; Climate Change; Livestock System; World Third Pole; Tibet.

1. INTRODUCTION

The Tibetan plateau occupies eighth places on the Republic of China; this plateau's average altitude is about approx. 4,000 meters. Tibet Autonomous Region, a major part of the plateau, which covers 12, 00,000 sq.km, is one of China's largest, but least developed and least populated, provinces. More than 3.0 million Tibetans (as per the 2010 census) live in this sub-region. Here, forests and Crops are limited to a few areas because of the short growing season, and pastoralism is widespread. For most of the highlanders, livestock is the only means of sustaining their food security and livelihood in this region. Pastoralism as a system, basically it is a complex livelihood system seeking to maintain an optimal sustainable balance between pastures, livestock, and peoples in uncertain and variable environments. Pastoral groups typically inhabit areas where scarce and unique resources and extreme climatic conditions limit options for alternative land use and livelihood systems.

So, there are two systems present like agro pastoral and pastoral. Agro pastoral systems are below 4,200 meters, where crops can be grown. And another view of pastoral systems are nomadic, the Tibetan plateau is one of the largest nomadic pastoral areas in the world and are usually at altitudes above 4,200 meters. Deeply changes in this both systems are taking place, with both negative and positive

impacts on the fate of the grazing land, because of promotion of infrastructure, re-structuring to encourage a market based livestock system, access to various services, nomads and allocate pasture and their limited mobility, Prolongation of natural reserves, such as Changtang natural reserve, which limit the areas of grazing and mobility of herders; improvement of transport and communication networks, formation of new markets, various environmental issues like; Climatic change, such as increased temperature and decrease in rainfall and as well as increasingly frequent natural disasters such as snowstorms and drought etc. All these changes are altering the future fate of Tibet's grazing lands including their pastoral systems and affect herders' way of life and the ecosystems on which will be livelihood depends.

2. REVIEW OF LITERATURE

A growing body of literature addresses The Tibetan pastoral area, located on the Tibetan plateau (also known as the 'world third pole' / water tower of Asia) in western China, is one of the world's most remarkable grazing land ecosystems (Ekvall 1974; Cincotta et. al. 1991; Miller 1998). In China's pastoral region, including the Tibetan areas traditional grazing management strategies and livestock production have been greatly altered in the past several decades as the nomadic way of life has been transformed to one more oriented toward a market economy (Cincotta et al. 1991; Miller 2005). The Tibetan pastoral area sustains an estimated three million agro-pastoralists and two million nomads and an additional support a large livestock population of some 11 million yaks and 34 million sheep and goats. FAO was using a broad definition of pastoralism: "extensive livestock production in the rangelands". Tibetan pastoralism is distinct ecologically from pastoralism in most other regions of the world (Ekvall 1968; Miller 1999).

Any successful pastoral production systems on the world (including Tibet) must have access the various natural resources like, shelter, forage, water, feed, etc. needed to support livestock to produce off-take products, livestock that converts forage and other feeds into products (i.e., meat, milk, fiber, manure, hides, etc.) that are directly consumable by the producer's family or that can be exchanged for other products or cash in the market place; – relatively few people dependent upon environmental resource use for their immediate livelihoods. (Sheehy et al., 2006). The traditionally forage-based, widely managed pastoral livestock production systems that have existed for mullein on the Tibetan plateau, however, are showing declines in overall productivity. For example, about a third of the rangelands on the Qinghai-Tibetan Plateau is currently considered moderately to severely degraded (Kellems and Church 2001). In the Tibetan Autonomous Region, the percentage of degraded rangelands increased from 18 to 30% of the total area of between1980 and 1990. Degradation is additionally a growing concern in Naqu Prefecture where degraded land makes up almost 40% of the entire degraded rangeland within the entire Tibetan Autonomous Region (Ciwang 2000). Some Kobresia-dominated communities in alpine meadows of the Tibetan plateau have deteriorated to such a degree that most of the sedges and associated grasses have disappeared, leaving annual plant species and bare soil termed "black beach". Overgrazing and burrowing by pikas have been implicated as major causal factors of this degradation, although climate change and increasing aridity may also play a role (Miehe 1988). This degradation calls into question the long-term sustainability of the Tibetan plateau under current use (Kellems and Church 2000).

The authors, (Sheehy 2000; Miller 2005) also say that, the grassing land resources of the Tibetan plateau in China. They also characteristic the main challenges that exist in trying to balance the needs for ensuring that, this unique landscape continues to maintain critical water sources, provide habitat, maintain biological diversity and forage for domestic livestock and wildlife. The hope is that discussion will shed light on the ongoing decline in livestock productivity and ecological stability of natural resources on the Tibetan plateau, and assist in devising meaningful solutions to problems affecting the sustainability of households and production systems on the plateau. This paper draws heavily on information contained in studies by (Sheehy 2000; Miller 2005).

The organizational flexibility of traditional Tibetan pastoralism, which emphasized mobility of the multi-species herds, developed as a rational response to the unpredictability of the ecosystem (Cincotta et al. 1991; Levine 1998; Miller 1999; Wu 1997a). The economic viability and environmental sustainability of Tibetan pastoral production systems are under considerable scrutiny these days (Ciwang 2000; Sheehy 2000; Wu and Richard 1999). The livestock sub-sector has experienced especially strong growth and rapid expansion during the past 20 years and thus the livestock sub-sector has consistently outperformed the agricultural sector as an entire (Nyberg and Rozelle 1999). Grazing animals and grazing based livestock production systems remain an important component of the world's food supply (Kellems and Church 2000). Rangeland, which produces forage for grazing animals and is more suited for grazing rather than cultivation, occupies 40% of the 13.7 billion hectares comprising the earth's land surface.

China is facing major difficulties handling the simultaneous problems of improving the livelihoods of the pastoral population while protecting and maintaining the various economic and environmental benefits provided by rangeland ecosystems (Smith and Foggin 2000; Sneath, 1996). Chinese rangeland research primarily focuses on biotic interactions among soils, plants, and herbivores, with little attention paid to the behaviors and motives of the pastoralists. When Chinese researchers do specialize in pastoralists, the knowledge is usually limited to narrow economic parameters, reporting such figures as animal units, stocking ratios, and production/consumption levels (Williams 2002). China controls a major share of these pastures and rangelands of the Tibet area. Three-quarters of its rangelands are located in the climatic zone of semi-arid, sparsely settled areas of the north and west of the PR of China. Out of China's approx 400 million hectares of rangeland, 145 million hectares are to be found in mountainous regions of the Tibetan Plateau; also, there are 57 million hectares of natural pasture in Xinjiang. Both areas comprise about one fifth of China's land area. Close to 40 million people live in 260 predominantly pastoral counties (Miller 1996). In an ecological definition, the Tibetan plateau covers 165 million hectares equaling quite two-fifths of China's grazing areas (Sheehy 2006). The pastoral systems developed by Tibetan were a successful adaptation to life in one among the foremost inhospitable places on earth (Clarke 1998, Manderscheid 2001; Goldstein and Beall 1990; Miller 1998). According to Yeh et. al., (2017) also said that the Tibetan Plateau is a huge ecological area perfectly predisposed for mountain pastoralism. Debates about pastoral practices, common property regimes, and rangeland management have gained pace in recent years since the environmental challenges and economic returns are discussed within the framework of climate and global change.

At least, this Tibetan area's other thinkable problem is climate change. This change also contribute to this area's melting of glacial and periglacial. That types of changing condition also modified the patterns of the pastoral system of Tibet. So, some proved of the article said of this area's climate change conditions like, According to the Intergovernmental Panel on Climate Change (IPCC, 2007), if trends in greenhouse gas emissions are not fundamentally altered, global temperatures are rise in between 1.4º to 5.8º C by 2100. Aside from experiencing evidence of climate change, herder communities on the Tibetan Plateau have also witnessed dramatic social-institutional transformations over the past decades. Herder's communities are increasingly linked to the rapid economic development in China; such development offers both opportunities and challenges for herder communities (Kreutzmann, 2011).

On the one hand, integration into the rapidly growing Chinese economy could provide more opportunities for herders to increase their household income by expanding livestock production and diversifying their livelihood choices (Nyima 2003). On the other hand, it is said that transformations in social-cultural institutions may undermine the adaptation capacity of herder communities to climate variability and change. Recent studies found that privatization and grazing sedentarization have reduced the pliability of rending land resource use by herders (Wu and Yan 2002; Foggin 2008; Klein 2011; Tashi and Foggin 2016). So, overview literature are suggest that, to increase the time period Tibet's pastoral system has been changed.

3. OBJECTIVES

i. To investigate the Tibetan plateau area's grazing land and livestock production system and showing the transformational of the pastoral system.
ii. To suggest the scope for exploring opportunities for sustainable development of pastoral systems.

4. STUDY AREA

The Tibet plateau Region (fig. 1) (hereafter referred to as Tibet Autonomous Region) is in the southwest part of China, from latitude 26°50'N to 36°53'N (2 000 km) and from longitude 78°25'E to 99°06'E (1 000 km). It has borders with the provinces of Xinjiang and Qinghai in the north, Sichuan, and Yunnan in the southeast, and with India, Nepal and Bhutan in the southeast. In the south-west, near Nepal, is the highest and most magnificent mountain range in the world, the Himalayas. In north-east is vast, open pasture land (Changtang means "the vast land in the north") where nomads live by yak

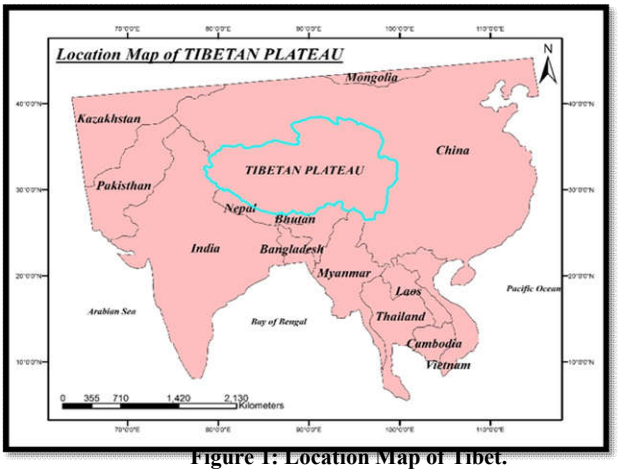

Figure 1: Location Map of Tibet.

rearing. Central Tibet, with mountains and valleys between 4,500 mts. and 3,500 mts, is a land of barley farming, where the majority of Tibetans live, eating barley as their staple food. So, this demarcate area is Tibetan plateau.

5. DATA AND METHODS

For the present study data set compiled from various secondary sources like Land Management Bureau of Tibet Autonomous Region, MAPTAI, Statistic Bureau of Tibet, Dr. Liu Yanghua of the Institute of Geography, and Chinese Academy of Sciences.

Also calculated the data by using MS Excel format 2014, and ArcGIS 10.2.2 and prepared the mapping by using the various types of techniques of ArcGIS application 10.2.2 and figurate the bar diagram using the MS Excel format 2014.

6. PRE- FINDINGS

To discuss the main theme of the pastoral system, primarily explain an overview concept of Tibet plateau area's climatic, topographical, and biodiversity based features, It helps to the understanding of this area's pastoral livestock system and why changing the transformational pastoral system of this area's? And something about it.

6.1 Climatic Condition

Tibetan plateau as a unique climatic region. Average, (Yearly) Temperature 23ºc (June/ Max), -10ºc (January/ Min), Precipitation 420 mm., No. of rainy days – 60 days, Time of sunshine – 8 h/day. etc. and the climatological issues of here present the Glacial and Permafrost covers extensive parts of the northern and north-western plateau due to their natural climate. But in this present era's most thinkable problem is Climate change. This change also affected the Tibet area's glacial and Permafrost. When melting the glacial (o/p sediment) and permafrost (o/p carbon fluxes). These conditions also effected (changing) this area's Biodiversity (Environment) and man's socio-economic activities (like pastoral etc.).

6.2 Topographical characteristics

The great variations of topography, with elevations ranging from 500 mts. to 8,848 mts, and the vast extent of the plateau, leading to obvious vertical zonation and horizontal patterns of climate, soil, and vegetation. According to Leber, Holawe, and Hausler (1995), the Chinese Academy of Sciences in 1992 classified Tibet into seven physiographic units, more natural vegetation oriented than an exclusively topographic classification. Southern slope of the Himalayan zone of rainforest and montane evergreen broad-leaf forests, mainly about and below 2 500 m and right down to 500 m. This region, which borders northeastern India along the lower reaches of the Yalongtsangpo river, includes most of Chayu, Metok and Cuona counties.

Gorges and Ranges of the East Tibet zone of montane coniferous forests. This region is a mostly steep mountain area and cut from north to south by several rivers, such as Lancangjiang and Nujiang, Jinshajiang. Most of Changdu Prefecture lies in this region. Upper reaches of Nujiang zone of montane shrubby plateau and Nakchu, mostly covered by an alpine meadow in the south and alpine shrubby plateau and meadow in the west.

Broad basins and valleys of the south Tibetan zone of the montane shrubby plateau, which is the main producer of grain and crops. Most of the population is concentrated here, along the Lhasa, Yalong tsangpo and Niachu rivers. Changtang plateau zone of the alpine plateau, which is now largely a protected natural wildlife reserve. This region is a very typical region of this plateau semi-arid, cold monsoon climate. It consists of much of the western part of Nakchu Prefecture and the eastern part of Ali prefecture.

Mountain and basin of Ali zone of montane plateau and desert, with an annual mean temperature of 0°C and annual precipitation only 50-200 mm. This region is very dry and cold. Despite the cold and dry climate, perhaps also because of it, this region is the largest producer of cashmere. Basin zone of alpine desert plateau and desert and Kunlun Mountain. Most of these regions are uninhabited, with a mean annual temperature of about -4°C. This region belongs to the plateau cold monsoon type arid climate. The far northern part in Nyima county of Naqu Prefecture and northern Gaize and Ritu counties of Ali Prefecture are in this region.

6.3 Floristic features of the Tibetan plateau

This table (Table no.1) is representing that, Major vegetation types and plant communities in the Tibetan Autonomous Region. Tibet's every region, there's a various sort of plant communities that change in species composition and structure supported factors like elevation, aspect, drainage, and precipitation. For example, Chang and Gauch described 26 plant communities in western Tibet, and Achuff and Petocz (1988) identified 18 communities within the Arjin Shan Region of Xinjiang on then another edge of the Tibetan plateau. Vegetation on the plains features a broad horizontal zonation and on the mountain slopes features a relatively narrow vertical zonation, both supported precipitation and elevation. China's grassland resources on the Tibetan plateau were surveyed and mapped in the 1980s and

Vegetation Type	**Dominant plant species**
Alpine meadow	Kobresia spp
Alpine shrub meadow	Rhododendron-Kobresia
Sub-alpine shrub meadow	Sabina-K.bellardii.
Mountain shrub plateau	Sophora viciifolia–Pennisetum flaccidum
Mountain plateau	Artemisia stracheyi–K.bellardii
Alpine plateau	Stipa purpurea
Mountain desert plateau	Stipa glareosa
Mountain desert	Ceratoides latens–Stipaspp
Alpine desert	Carex moorcroftii
Alpine cushion vegetation	Ceratoides compacta
Lake basin and valley meadow grassland	
Woodland meadow	

Table 1: Major vegetation types and plant communities in the Tibetan Autonomous Region (Source: GU 2000, Mou, 1992)

classified into 17 vegetation types based on climatic zones, humidity index, vegetation, and importance to the livestock industry. These vegetation types, their aerial extent, and the percentage of the total area of the Tibetan plateau are presented in table 1. Others classified rangelands of the Tibetan Autonomous Region into 12 different types. These 12 vegetation types and associated dominant species are presented in table 1.

So, Tibet plateau area's pastoral system grown and developed based on this area's climatological, topographical and biodiversity cal conditions. So, this traditional system also changed and changing due to this area's physical (main) and socio-economic (Minor) causes.

7. Results and Discussion

7.1 Status:

7.1.1 Major pasture types:

Pasture types are determined by climate and vegetation, soil. From southeast to northwest, pasture type varies from tropical and subtropical to warm and temperate to cold, and from humid and sub-humid to semi-arid to extreme dry types. According to, the Tibet Bureau of Land Management, (1994) classified 17 different types of grazing land. The Cold highland plateaux are the largest in the area and the most widely distributed type. It is mostly found in Naqu Prefecture and Ali Prefecture. Cold highland meadow is the second largest in the area of Tibet and is found in all parts of Tibet. The cold highland desert plateau is the third-largest in the area but is only found in Naqu and Ali Prefecture. There are warm and tropical pasture types, but they are limited to Linzhi Prefecture, where it is lower elevation and humid (details are given in Table 2).

Table no:02 Proportion of different pasture types in the seven Prefectures of Tibet

Sl_No	Type of grazing land	Lhasa	Linzhi	Changdu	Shigatse	Ali	Naqu	Shannan
1	Temperate meadow stepp		12.18	75.3	7.87		4.65	
2	Temperate plateau	18.99	1.57	17.65	34.58	2.19		25.02
3	Temperate desert plateau					100		
4	Cold highland meadow plateau	1.9			20.89	2.38	72.55	2.28
5	Cold highland plateau	0.38			16.58	39.79	43.08	0.17
6	Cold highland desert plateau					44.55	55.45	
7	Temperate plateau desert					100		
8	Temperate desert					100		
9	Cold highland deser					45.29	54.71	

10	Warm pasture		100					
11	Warm brushy pasture		30.58	69.42				
12	Tropical pasture		100					
13	Tropical brushy pasture		100					
14	Lowland meadowe	19.51	20.11		60.38			
15	Mountain meadow	4.2	7.6	82.35	2.66		1.09	2.1
16	Cold highland meadow	6.12	6.8	16.09	22.44	7.69	32.69	8.17
17	Marshland and wetland	10.22			65.24	24.54		
Note	Because of rounding errors, some types do not total exactly 100%							
Source	Land Management Bureau of Tibet Autonomous Region, 2010							

Among the 17 pasture types, there are seven - Cold highland desert plateau; Cold meadow plateau; Cold highland plateau; Cold highland meadow; Cold desert plateau; Temperate plateau; and Mountain meadow - comprise some 98 percent of the total. Their area and percentages of the total are shown in (Table 3).

Table no.- 3 Area of major pasture types and their proportion of the total area in Tibet

Sl_no.	Pasture type	Area ('000 ha	Of %
1	Cold highland plateau	31588.6	38.5
2	Cold highland meadow	25367.33	30.91
3	Cold highland desert plateau	8678.67	10.6
4	Cold meadow plateau	5938.67	7.2
5	Cold desert plateau	5441.33	6.6
6	Temperate plateau	1793	2.2
7	Mountain meadow	1254.67	1.6
Total		80062.27	97.61

Source: Land Management Bureau of Tibet Autonomous Region, 2010

There are present the seven agro-ecological zones in Tibet (Fig. 2). There is a hot humid agro-forestry zone in the southeast, it is mainly forest area, where livestock depends on forage cut from the forest, with grazing in the warm, tropical shrub pasture. Goat, Yak, cattle, and swine are common. Shifting cultivation is seen in many villages. It has distinct wet and dry seasons, affected by the monsoon. Here, most of the crops are rainfed. In the Winter wheat, winter maize, barley, and even rice are the major crops. The warm semi-humid agro-forestry zone is where major rivers such as Lancangjiang, Jinsha Jiang and Nujiang flow south out of Tibet. Moisture comes through the river valley and the climate is affected by the

monsoon wind. one of the pastures of Shrub pasture is the main resource for stock raising. Yak is a predominant animal in livestock production.

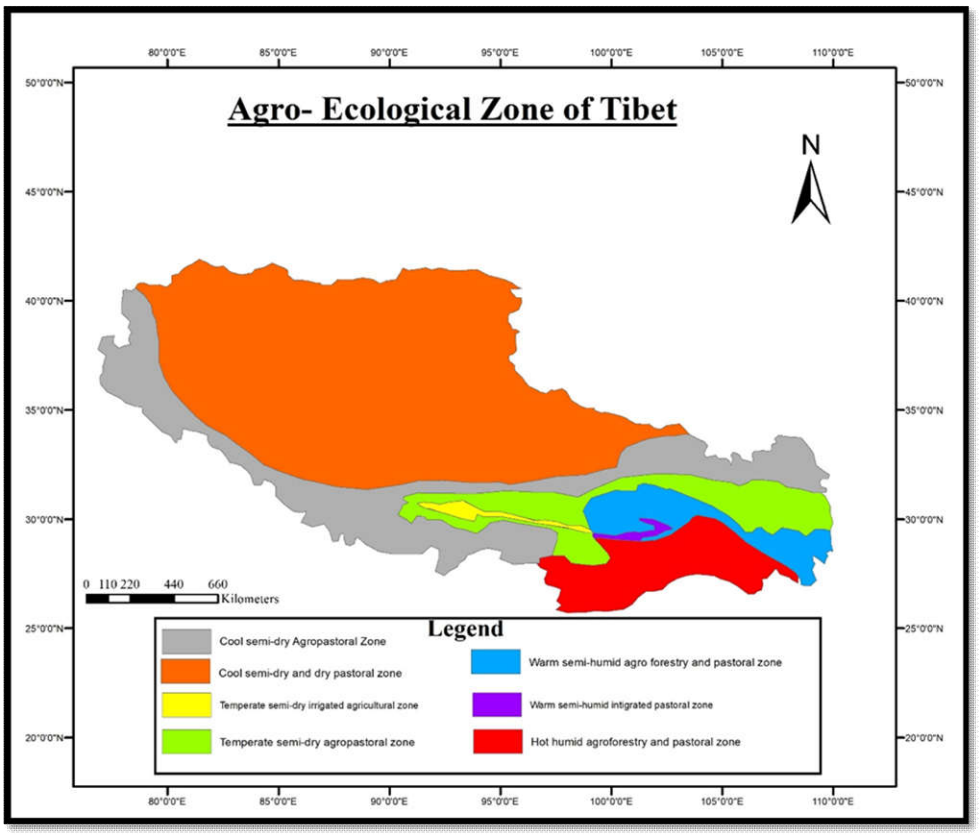

Figure 2: Agro- ecological Zone of Tibet

7.1.2 Livestock production systems

There are presently four types of livestock production systems (Figure 3)

- ✓ Crop-based livestock production in central areas,
- ✓ Pastoral systems in northern Tibet.
- ✓ Between these is the agro-pastoral production system.
- ✓ An agrosilvi pastoral mixed production zone.

There is great variation within production systems, particularly this variation is the effect on

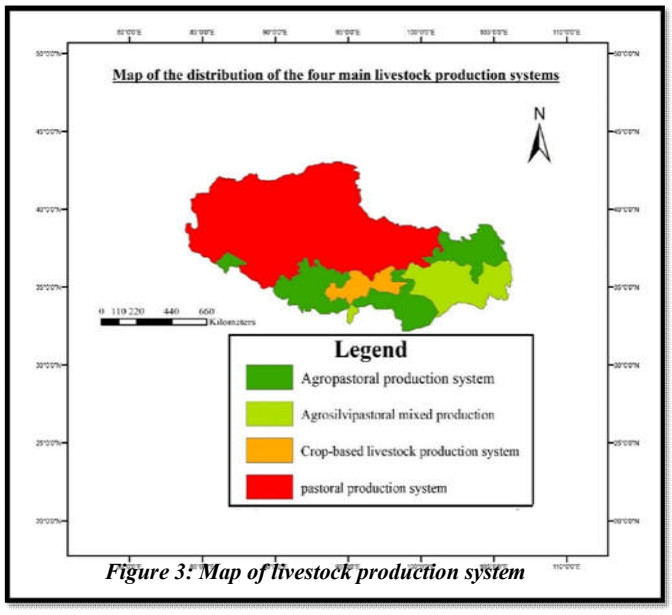

Figure 3: Map of livestock production system

crop-based livestock systems. Most households, except purely grow crops, pastoral ones, keep livestock and diversify activities to generate income and ensure food security. The areas of grasslands in each system are figure out in the following Table no. 4. Generally, there is only a little grazing land is present in crop-based livestock systems, but they have a larger proportion of sown grassland. More degraded land is found in the pastoral system livestock area, while the most improved grassland is in the agro-pastoral zone (Table no. 4).

- ✓ **Crop-based livestock production system**

This livestock production system includes the majority of Lhasa Municipality and some counties of Shigatse and Shannan Prefectures. It occupies the river valleys of the middle reaches of Brahmaputra River and its two tributaries, Lhasa Stream and Nyachu Stream (known locally as One River, Two Streams).

The main production is cereals and rapeseed. The average altitude is 3 800 m. Precipitation condition is unevenly distributed, both spatially and seasonally: 90 percent occurs from June to September, with 80 percent falling at night. Winter and Spring are dry, with an annual average relative humidity of 46 percent. Strong wind and sunshine, especially during the spring, lead to high annual evaporation - 2 425.5 mm, almost six times the level of precipitation. Crops are prone to drought in spring and waterlogging in autumn. In higher areas, crops are damaged by autumn and spring frost, and by hail in late summer and early autumn. Over half the urban areas and half the arable land area in the crop-based system, which accounts for over 56 percent of grain and 70 percent of rapeseed. Although crops dominate the economy, the area still has 16 percent of the animals, 16.1 percent of meat production and 22 percent of the milk production of the whole of Tibet. Pasture has relatively low productivity, due to rainfall is low. Zo and yak are the main draught animals **(**fig. 4**).** In the area of lower valleys, milk is mostly from cows; higher up it is from yak and zo. In this zone, peoples mostly eat milk, grain and little meat as butter tea. In terms of energy intake, barley makes up over 80 percent for farmers. In urban areas, rice and wheat consumption is increasing and accounts for 35 percent of energy intake.

Figure 4: Yaks and their hybrids are easily trained for drought and as pack animals.

Table no.- 4 Grassland resources in the four livestock production systems in Tibet

Sl_no	Grassland type	Total ha.	Crop-based		Agro pastoral		Pastoral		Agro silvipastoral	
			ha	of %	ha	of %	ha	of %	ha	of %
	Natural grassland (total)*	64316707	4162000	6.47	15696757	24.41	41014425	63.8	344352 5	5.35
1	Cold season	11917880	239051	2.01	2304255	19.33	9137122	76.7	237452	1.99
2	Warm season	36756106	2316369	6.3	10135116	27.57	21653426	58.9	265119 5	7.21
3	Non-seasonal	8803142	1542325	17.5	2442007	27.74	4458605	50.6	360205	4.09
4	Grazing-mowing	19022	554	2.91	17682	92.96	122	0.64	664	3.49
5	Temporary grassland	335415	3256	0.97	243822	72.69	54875	16.4	33462	9.98
6	Degraded grassland	2414241	65822	2.73	553882	22.94	1635991	67.8	158546	6.57
7	Improved grassland	4383	560	12.8	2688	61.33	500	11.4	635	14.49
8	Sown grassland	5491	3854	70.2	293	5.34	1016	18.5	328	5.97

Note: * Depending on the source of the data, the total grassland area varies between 64.3 million hectares and 64.8 million hectares.

Source: Land Management Bureau of Tibet Autonomous Region, 2010

- ✓ **Agro pastoral production system:**

Mainly, agro pastoral production system includes northwestern Shigatse, northern Changdu, and southern Shannan Prefectures. It is in the upstream valleys of the Nujiang, Yalongzangpo, Cuona, Longzi, Lancangjiang and Jinshajiang Rivers. This system is spread over the cold semi-arid highlands, with a few cool semi-arid areas at 4,000-4,500 m. this zone suffers from snow, gales, frost, and hail which severely restrains the development of agriculture. Because of high altitude and cold, most land is for grazing or barren; large amounts have been cultivated in lower valleys. In a few counties in lower areas, some apples and peaches are grown. Crops and livestock (cattle, sheep) have equal importance in farming. Here, barley is the main cereal, making up over 68 percent of the total crop area. In lower parts, spring wheat is grown where as soon as possible. Goat, Cattle, yak, sheep, and chicken are the main livestock. The number of production of meat, production of milk and animals are 45 percent, 40 percent, and 47 percent, respectively, of Tibet's output.

✓ **Pure pastoral production system**

This pastoral system area is surrounded geographically by the Kunlun Mountains in the northwest, the Himalayas in the west, the Gandisi Mountains in the southwest, the Nianqingtanggula Mountains in the southeast and the Tanggula Mountains in the east. It occupies almost 60% area of Tibet, with a total area of 7,11,000 km2. Climatologically, this area is cold semiarid or arid, with an average elevation above 4 600 m. The annual average temperature is below 0°C, with an average of 7.3°C in the hottest month and -7.5°C in the coldest. y). Cropping is impossible in most of the zones, and even animal husbandry is limited by harsh natural conditions; disasters such as frost are frequent, wind storms, hail and nomads, in particular, often suffer from snow calamities. Heavy snowfall in 1997-1998 nearly caused the collapse of the livestock production system, as about half of the livestock died. Livestock system depends on grazing; there are little forage and hay. In the east, grassland is dominated by swampy meadows and highland meadows which are relatively productive and can support large grazing animals; the yak predominates (figure 5 & 6). Over 80 % of livestock, in sheep equivalent units, 70 percent of the nomads' income and is a yak, which provides almost 80 percent of meat and milk. In the west portion, pasture is mainly alpine desert plateau and alpine plateau which cannot support large ruminants, but local sheep and goats are well adapted to the conditions. This zone currently supplies over 56 percent of sheep wool, 36 percent of meat, 47 percent of milk and 40 percent of sheepskins of Tibetan production.

Figure 5: Yak breeding station on the high plateau at over 4,500m

Figure 6: A warm welcome at the yak breeding station at 4,300 m in Linzhou county, 70 km from Lhasa, Tibet

✓ **Agro silvopastoral mixed production**:

This prevails in the middle valleys of the Lancangjiang, Nyiyang, and Nujiang Rivers, including the entire Linzhi Prefecture, Zuogong, and Mangkang Counties of Changdu Prefecture - nine counties altogether. In more favorable conditions of environments, crops, livestock, and forestry co-exist and are fundamental to ensuring food and livelihood security. Affected in this area's topography and the monsoon from the Indian Ocean, the climate varies horizontally and vertically. Vertical differentiation of climate conditions and vegetation characteristics are much more marked than horizontal differentiation, and greater than in the other

three systems also. Climatic variation ranging from hot humid criteria in the south to warm humid in the middle range, and to temperate semi-humid in the north, and even too cold arid in the higher altitudes. The livestock production system has developed over a long time, typically incorporating different resources through forestry, cropping and livestock raising and it's similar to some Indian mountain pastoral system (Malakar, 2020b and 2020c).

7.2 Transformation of traditional pastoralism system

7.2.1 Background of Tibetan pastoralism

Historically, Pastoralists have probably been raising stock on the Tibetan plateau area for about approx 4,000 years. As early as the Hsia Dynasty approx (2205-1766 BC), nomadic Qiang was making fine woven woolen material in the Kunlun Mountains. During the Shang Dynasty (1766-1027 BC), nomads in eastern Tibet were renowned for their horses. The development of Tibetan pastoralism was shaped by nomads from Central Asia who brought goats, horses, and sheep. Most herders on the Tibetan plateau are Tibetan, but there are small groups of Kazakhs and Mongols in Qinghai Province. Population density across much of this plateau is less than two (02) persons per km2. For a distance of almost 3,000 km. In recent decades, pastoralists across most of the plateau's areas people have built houses and livestock shelters on traditional winter-spring pastures where they spend up to 6 to 7 months of the year. The majority of holders has been "settled" for some time, but graze their livestock in a transhumant manner. Tibetan pastoralism has evolved through long-term adaptation and persistence by holders. Pastoralists traditionally kept a mix of livestock species and classes and used a mosaic of grazing sites that exploited seasonal land annual variability. Herders bartered products for grain and supplies, and quite elaborate trade linkages developed between pastoral and agricultural areas. Tibetan pastoralism is different ecologically from that of other semi-arid regions, except Mongolia, because it is separated from agricultural areas by temperature, not aridity. They (Bosgrunniens), which is well adapted to the cold Tibetan plateau, also distinguish Tibetan pastoralism. The domesticated yak enabled nomads to effectively harvest vegetation types on the harsh Tibetan plateau.

7.2.2 Changeable status of tenure of land

Before 1950, the feudal "estate" system of land tenure existed with land controlled by religious and aristocratic elites. Wealthy, powerful monasteries controlled huge fiefdoms with numerous pastoral estates and thousands of subjects. Holders were bound to an estate and not free to leave it, but owned their animals and managed them as they wished. Herders paid taxes and worked for their lord. Traditionally, pastoral estates were divided into numerous pastures, with borders recorded in a register book. Households were allocated grazing land according to the number of livestock owned, including multiple pastures for use at different seasons. The system balanced rangeland livestock and resources by reallocating pastures among families according to a census conducted every three years. Holders whose stock numbers increased during the previous three years were allocated more grazing land, whereas those with declining stock numbers lost land. The system aimed to maintain a specified number of livestock on each pasture. These groups were divided into "encampments" of five to ten households, and each encampment had rights to a set of seasonal grazing areas within the wider "tribal" territory

(Malakar, 2020a; Maity et al. 2020). Natural features such as ridges and streams marked boundaries. Holders had heritable grazing rights within a group territory. In these areas outside the control of large pastoral estates, grazing rights were very insecure and depended on the force. While the rights of tribes to certain tracts of land were fixed, rights of encampments were more fluid. The camping sites and grazing grounds of the various groups could be changed from one part of the tribal territory to another at the discretion of tribal leader sand in response to changing needs of the encampment. In the Golog Region of the north-eastern plateau, winter camps had a sense of "ownership" by specific encampment groups. Here, the households in the encampment had "individual and exclusive rights over certain hay fields" near winter sites.

Since 1949, the Chinese Government has induced profound changes in tenure and social organization of pastoral communities. In the decades of 1950, when the land reform process was being implemented throughout China, grazing lands were nationalized, and aristocratic and monastic lords lost their estates. Although However, State ownership of grazing land was not incorporated into law until 1982. When communes were established in the late 1950s and 1960s, ownership was vested in production teams, which came to regard rangeland as collective property. Thus, a de facto situation emerged with State-and collectively-owned pastures. All livestock were the property of the communes with herders holding shares in the communes' livestock. In the commune era, however, mobile pastoralism continued, and no attempt was made to scale back the geographic scope of livestock production.

In the agricultural areas, farmers could land-use rights and lease land could be subcontracted or inherited. The contract system became the orthodox sort of tenure for agriculture and was applied to grasslands with the promulgation of the Grassland Law in 1985. This Law stated that the user rights of State or collective land could be leased "long-term" to households, although in practice lease periods typically extended to 30 years and in special circumstances to 50 years. In most of the pastoral area of southwest Gansu, Qinghai, and north western Sichuan Provinces, many herders have settled and fenced pastures contracted to them.

7.2.3 Livestock dynamics and climate

The strong continental climate and periodic weather perturbations that occur on the Tibetan plateau within the sort of sudden, brutal snowstorms increase the complexity and dynamic nature of the plateau. Snowstorms are a fundamental feature of climate on the Tibetan plateau and doubtless function a crucial regulatory mechanism within the pastoral system. Seriously losses occur as a result of heavy snowfalls and severe weather. Like, example, from 1955 to 1998 six severe winters with heavy snow were reported leading to 22 to 33% livestock losses with each winter. Similarly, the winter of 1995-1996 was severe in many parts of the plateau with 33% livestock loss in the Yushu Prefecture of Qinghai Province. In Naqu Prefecture, 20% of the pastoral population of 340,000 lived in poverty before the severe 1997-1998 winter, whereas the poverty percentage increased to 40% the subsequent year. Losses thanks to unseasonably weather during summer also are common. for instance, Goldstein and Beall found that after five days of snow within the summer of 1986, one herding area lost 30% of its livestock. Holding on the Tibetan plateau has always been a high-risk

enterprise, and pastoralists have adopted strategies that minimize risk and make the simplest use of grazing resources.

7.2.4 Management of Livestock systems

Pastoral practices are similar across this plateau, although the composition and size of herds differ. Herders keep herds of goats, yak, sheep, horses, and yak-cattle crosses. Yaks are preferred at extreme altitudes, in snow, and for riding in rough country. Their dung is additionally a crucial fuel. Sheep and goat sare most vital within the west, and are milked there. within the eastern portion, yaks supply all the nomads' milk needs. Mutton is that the preferred meat, whereas goats yield cashmere, meat, and milk. Since disbanding of the communes, livestock is owned by individual families who are liable for their livestock, and therefore the processing and marketing of livestock products. The proportion of livestock species and therefore the size of Tibetan herds differ consistent with specific rangelands and the suitability of the landscape for various animals. Herd compositions within a geographical area also can differ with Government policies, herders' skills and livestock preferences, and availability of labor. Traditionally, extensive grazing management of Tibetan plateau was adapted to their local conditions, and livestock was regularly moved between pastures to take care of rangeland conditions and animal productivity. Grazing lands were divided into seasonal pasture sand grazed consistent with managerial and production objectives. The pastoralist's movements were well prescribed by complex social organizations and were highly regulated. Mobility remains vital for many herders, although, with the escalating settlement, livestock mobility is being curtailed. the normal system was designed around the seasonal movement of livestock with herds using forage in summer and reserved for age areas for autumn and early winter to organize animals for the long winter. Today's survival of various, prosperous groups of Tibetan pastoralists testifies to their extraordinary indigenous knowledge, resourcefulness, and farming skills. During a previous couple of decades, traditional livestock and grazing management systems are altered, and that they are continuing to vary today.

7.2.5 Transformation of traditional pastoral systems

The profound changes of tenure that occurred during recent decades transformed traditional land use, altered pasture conditions, and disrupted the lives of pastoralists. Often these ecological, political, social, and economic transformations altered previously stable relationships between pastoralists and grazing lands. for instance, within the mid-1980s, winter grazing lands were allocated to households, and winter pastures were fenced. This began in areas near Qinghai Lake but quickly spread to herding areas in Gansu and Sichuan Provinces. Exclusive rights to specific grazing lands for herding households can now be inherited, but not bought or sold. There didn't mechanism yet in situ for the readjustment of pasture to individual families when livestock numbers fluctuate. within the Tibetan Autonomous Region, rangelands are being allocated to groups of holders instead of to households. the reason for the difference within the privatization process in Tibet is that rangelands there aren't as productive and expenses for fencing individual properties would be prohibitive. A recent development on the plateau is that summer grazing lands also are being privatized and fenced, except again within the Tibetan Autonomous Region where they're being allocated to groups rather than households. These activities are being undertaken on an outsized scale

in most pastoral areas of Qinghai, Gansu, and Sichuan Provinces with substantial Government and donor investment. Great attention is being given to settling of holders, even in Tibet. The heavy livestock losses experienced on the Tibetan plateau in recent years has convinced many authorities that transhumant pastoralism must be restructured. Programs to settle herders, privatize and fence pasture, and develop fodder for winter are seen as ways to stop losses in severe winters and control what's perceived as widespread pasture degradation. While a number of these interventions have merit, like the expansion of annual forage for hay, the long-term ecological implications of privatizing rangeland and reducing the spatial movement of herds have received little analysis. The socio-economic conditions and land-tenure ramifications of holders being settled on defined properties have also not been examined. Login and Smith suggested that summer-autumn pastures could also be unintentionally degraded further as artificially high winter livestock populations are forced to graze on reduced areas of summer-autumn pasture.

7.2.6 Changing the trends of pastoral systems and livestock production in Tibetan plateau:

Livestock growing comprises more than 62 % of gross agricultural output and is fundamental to ensuring food security. Historically, here the number of livestock was about 10 million heads. Socio-economic conditions changes in the 1950s and 1960s resulted in stock numbers increasing rapidly. Livestock systems are in transition, driven by increasing demand for livestock products, particularly meat and milk, due to the human population increase, income growth, and changing lifestyles and food preferences. The number of livestock's: here, the quantitative increase towards the qualitative improvement of the total number of livestock has had three distinct development stages like; firstly, fast-growing, secondly, steady-growing, and lastly, stagnant. This changing trend has been plotted line diagram, (figure no- 7).

Table no.-5 Changes in the total population of livestock - 1952 to 2010

Years	Million head		
	Total Animal	Sheep & Goats	Large animal
1950	10	7	3
1955	12	8	4
1960	13.3	8.5	4.8
1965	15	10	5
1970	20	14	6
1975	21	15	6
1980	26	19	7
1985	25	18	7
1990	24	17	7
1995	25	17	8
2000	23	15	8
2005	24.2	16	8.2
2010	24.6	16.8	7.8

Source: MAPTAI, 2014.

Fast-growing stage: Before the year of 1960, livestock numbered about 10 million head. It increased rapidly following democratic reform, liberalization and land reform. By the year of 1967, after just nine years, it had doubled, to 22 million head. The average annual growth rate was 10.47 percent during these periods.

Steady-growing stage: During 1960-1980, the average growth rate was about 1.8%. The tear of 1980, the number of livestock had reached 23.4 million heads also. While the numbers had increased, livestock development stagnated; it was devastated following the transformation of large areas of productive grazing into cropland. There was a greater emphasis on cereals than livestock. By the decades of late 1970, there

was hardly any growth in livestock numbers.

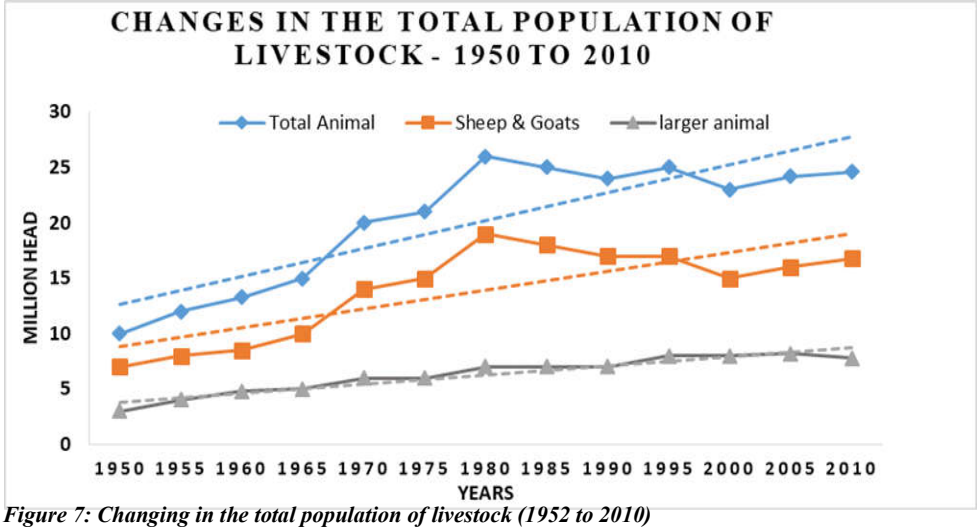

Figure 7: Changing in the total population of livestock (1952 to 2010)

Stagnant period: After the year of 1980, the total number of livestock was between 23 and 26 million. The average growth rate was about 0.16 percent. In recent years, there has been a slow growth process are containing, but it has not reached the level of 1975.

Overall, during the decadal time of the 1960s, the average growth rate was more than 10 percent (approx.). There was a slow increase in the 1970s, at an average rate of 2.16 percent (approx.). During the 1980s, there was stagnation, decreasing at -0.16 percent. In recent years there has been a slight increase in the livestock population. Particularly with increasing demand for pork in recent years, the number of pigs has increased at a rate of 6.6 percent annually, after a large decrease during the 1980s. And the total numbers of livestock has reached an alarming level compared with the carrying capacity of the pastures. Actions have been taken by the local government to control livestock numbers also. Guidelines for sustainable use of grazing lands and livestock development in the pastoral production system have been prepared, and a series of official documents have been formulated. One is the Pasture Law. It is laid down in the law that the number of livestock should be based on the area and productivity of the grazing land. In the implementation of this statement, certain measures have been taken, including fixing the number of livestock - particularly numbers of yak, cow, and sheep - according to an area of grazing land in each administrative village, and encouraging herders and farmers to improve the unit productivity of livestock. Guiding herders to focus on the profitability and unit yield of livestock instead of seeking an increase in number has been the focus of the reorientation and re-structuring of livestock production systems. Besides, traditionally, livestock numbers are perceived as the symbolic wealth of the household. Now some holders and farmers are encouraged to produce what the market wants, using local resources. General principles for the future development of livestock production were set as stable development of pasture-based livestock production; vigorous development of crop-based livestock raising; and accelerated development of pre-urban intensified livestock production. The main aim of this is to boost total livestock production without burdening the grasslands.

Pastoral production systems on the Tibetan plateau exist within the larger context of pastoral ecosystems in a cold temperate zone. The perception of how particular ecological systems operate determines the approaches that are advocated in attempting to modify or manipulate ecosystems to improve the sustainability of ecosystem use. Until recently, ecosystems occupied by pastoralists and thought to function as "homeostasis systems", which were regulated by pastorals' density-dependent feedback controls that pastoralists often override to the detriment of themselves and the ecosystems in which they operate. Today it's thought that a lot of ecosystems occupied by pastoral production systems are "none equilibrium systems", which are controlled by external mechanisms and aren't subject to feedback control mechanisms from within the system. However, Tibetan plateau ecosystems dominated by alpine plateau, alpine meadow, and temperate mountain meadow vegetation types appear to be more equilibrium than non-equilibrium systems, as evidenced by the impact of pika and overgrazing in moving these systems to a different "steady-state," (i.e., Kobresia turf communities degrading to the black beach). Effort store-establish natural communities in these vegetation types have generally been unsuccessful. As the stocking rate increases, either through continued degradation of ecosystem productivity or by increasing animal numbers, restoring ecosystems of the Tibetan plateau to a higher productive state will have even a lower probability of success.

It should be noted that traditional livestock importantly uses of the Tibetan plateau has been similar to a naturally functioning wild herbivore system. One difference between a wild herbivore system and plateau livestock production systems is the layer of control and management exerted by the herder on domesticated herbivores. This pastoral is control and management are necessary to ensure human livelihoods on the plateau and were instituted in response to current or future impending environmental constraints to mitigate the potential negative impacts on livestock directly affected and on the pastoralist's livelihood indirectly effected. Despite the appliance of control and management interventions, the system remains subject to an equivalent set of environmental constraints as wild herbivores. Although long-distance migrations that mimicked naturally functioning wild herbivore movements between seasonal pastures continue on the Tibetan plateau, this important factor of production and household sustainability is declining rapidly as herders become more sedentary. Herding families are becoming settled not only as a result of Government policies designed to promote privatization of production resources but also because overpopulation and overuse of natural resources are causes of the fundamental of social and economic changes among the holding households themselves. Among these factors, the decline of natural resources capacity to support animal production is the major stress on the cultural and social identity of Tibetan animal production households. With attempts to transform pastoral livestock production towards a market economy, increased livestock off-take has often been the goal.

This has been promoted through privatization of herds and land, settling of herders, production of rainfed forage, and introduction of less mobile, intensive grazing management. While many of these interventions have improved the delivery of social services, in many instances they have conflicted intending to maintain grassland health and stability because they limited the critical factor of mobility. Movements between seasonal pastures are being reduced or eliminated, herd composition is being restructured along commercial lines, and herders are

being compelled to become livestock farmers. The environment and the pastoral cultures are under threat where mobility has been substantially or eliminated reduced. There is a growing appreciation of the economic efficacy and complexity and ecological of traditional pastoralism. When analyzing transhumant pastoral production on the Tibetan plateau, one is faced with problems of two production strategies. First, there is a strategy involving the traditional indigenous system, which can be seen as an evolutionary response to a complex suite of environmental pressures. This different strategy represents a pattern of survival that has evolved through time and continues to exist today. Second, there is the news strategy for survival that focuses on balancing economic and ecological sustainability, based on technical rationale brought in from the outside. However, this latter strategy has not been fully accepted into the existing socio-economic structure on the plateau and has not been subjected to the test of time. Combining traditional pastoral strategies with sustainable strategies in today's context will critically hinge on the successful incorporation of indigenous knowledge from pastoralists. New production systems on the plateau will only be successful when pastoralists' needs and desires are heard, and their indigenous knowledge incorporated into the design of new strategies.

8. CONCLUSION

So, overviews its saying that the rangeland ecosystems on the Tibetan plateau are the characteristics are more complicated, not only in the ways that physical forces shape the landscape, but also in the ways that socio-economic, institutional forces and political interact and impact the peoples who use the rangeland resources also. The people who use the plateau rangelands live in a multifaceted environment of physical, financial, social, educational, institutional, and regulatory forces that influence their actions. Sustainable pastoral system management development requires an examination of all the factors that affect the pastoralists who use the rangelands. However, despite the extent and importance of rangeland on the Tibetan plateau, rangeland ecosystem dynamics there are still poorly understood and sound scientific data on ecological processes on the plateau rangelands are limited. Many questions concerning that, how to rangeland vegetation on the plateau's functions, the effect of both domestic and wild herbivores on pastoral systems, and the socioeconomic dimensions of pastoral production on the plateau remain unanswered. This lack of information limits the proper management and sustainable development of plateau rangelands.

A better understanding of current nomadic pastoral practices and how they are changing and adapting to the influences of modernization is critically needed. The Tibetan plateau and the people who live there are in transition from a known past to an unknown future. Drastic political, economic, and social changes have occurred on the Tibetan plateau during the last half-century. Despite these changes, livestock production on the Tibetan plateau still critically depends on standing crops of forage to support livestock production activities throughout annual production cycles. Thus, the animal access to standing crops is a key element of forage-based livestock production systems on the plateau. However, ensuring livestock access to the standing crop of forage is becoming increasingly difficult as deteriorating rangeland conditions decrease the quantity and quality of standing crops. Livestock production by households throughout the Tibetan plateau is increasing in complexity as the production system is forced to respond

to new paradigms. An incomplete understanding of how to respond to new paradigms is affecting interactions between production resources, humans, and livestock throughout the livestock production system. And in the present thinkable issues is the pastoral systems of the world third pole are gradually change due to climate change (Malakar, 2019).

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