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Utilization and Management of Forage Resources in the Farming Area of Xizang Autonomous Region

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ABSTRACT

Animal husbandry in the agricultural areas of Xizang plays a significant role in the region's traditional economy. The core of pastoral production in these areas lies in the utilization and management of pasture vegetation. Based primarily on first-hand materials from field investigations conducted in Zhaxilin Village, Zhanang County, this study examines the local wisdom in utilizing and managing mountain pasture vegetation and field ridge vegetation. The villagers' management and use of mountain vegetation are realized through rational and effective livestock grazing strategies. According to the different types of livestock, herds are separated and grazed on the lower, middle, and upper slopes, with rotational grazing between East Mountain and West Mountain within the village territory. These strategies expand the utilization space of mountain pastures, reduce grazing pressure, improve the utilization rate of various forage plants, maintain vegetation diversity, and lay the foundation for sustainable use of mountain grasslands. The management and use of field ridge vegetation are based on collectively accepted rules and regulations, clearly characterized as "village conventions". The orderly utilization and management of vegetation are founded on a profound understanding of local natural conditions, climate, livestock behavior, plant characteristics, and the integration of vegetation resources across the village domain. Pastoral production in agricultural areas has expanded the breadth, depth, and elevation of the villagers' living space, providing better conditions for their subsistence.

Keywords: Xizang, Zhaxilin, animal husbandry production, forage management and utilization

1.Introduction

Agriculture and animal husbandry stand as the two long - established and significant pillar industries of Xizang. These two sectors have deep - rooted historical and economic significance in the region, having been the mainstays of the local economy for a long time. When we take a look at the situation from the perspective of the relative economic contribution made by animal husbandry, the entire region can be clearly categorized into three distinct types of areas. These are the pastoral areas, where animal husbandry is the dominant economic activity, the semi - pastoral semi - agricultural areas, which strike a balance between raising livestock and cultivating crops, and the agricultural areas, where the focus is more on crop production.

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However, it is quite remarkable that even in the so - called agricultural areas, livestock production still holds a considerable share. Specifically, it accounts for approximately 30% of the total local agricultural output. This proportion is not negligible at all. It clearly shows and emphasizes the crucial supporting role that animal husbandry plays in Xizang's traditional economic activities. In fact, animal husbandry acts as a solid foundation, complementing and strengthening the overall economic structure in Xizang, making it more stable and resilient in the face of various economic challenges.

Academic research on animal husbandry production is quite extensive, covering a wide range of aspects and perspectives. However, it is characterized by distinct thematic emphases, with different scholars focusing on various specific areas and issues related to animal husbandry production.

Xiao Qianchun (1954) and Zheng Peiyao (1955) were among the early researchers who provided descriptive overviews of livestock production in the agricultural areas of Xizang. Their works outlined the general situation of livestock raising and management in specific agricultural regions of Xizang at that time, laying a certain foundation for subsequent research on this topic (Xiao, 1954; Zheng, 1956).

The Xizang Social History Surveys (Volumes 1–4) primarily recorded the conditions of agricultural and pastoral pr oduction in certain regions of Xizang prior to the democratic reforms. These surveys comprehensively documented the production methods, scale, and related socioeconomic factors of both agriculture and animal husbandry in those specifi c areas before the significant changes brought about by the democratic reforms, providing valuable historical materials for understanding the development process of animal husbandry in Xizang (Editorial Group of the Tibetan Social Histor y Survey Series, 2009).

The Xizang Comprehensive Expedition Team of the Chinese Academy of Sciences (1964) proposed distinct priorities for integrating agriculture and animal husbandry in agricultural areas as opposed to pastoral areas. They carefully analyzed the different characteristics and requirements of these two types of areas and proposed corresponding integration strategies, which were of great guiding significance for the coordinated development of agriculture and animal husbandry in Xizang (Tibet Comprehensive Expedition Team, Chinese Academy of Sciences, 1964).

Zhang Jianshi (1994) delved into the technical linkages between the ecological environment and livestock production. He explored in detail how the ecological environment in Xizang influenced livestock production from a technical perspective, such as the impact of climate, soil, and water resources on the growth and health of livestock, as well as how livestock production activities, in turn, affected the ecological environment (Zhang, 1994).

Hu Songjie (1995) discussed the relationship between agriculture and animal husbandry. His research focused on analyzing the interaction and interdependence between these two major sectors in the context of Xizang, including aspects such as resource exchange, influence on economic development, and role in the overall agricultural structure (Hu, 1995).

Gelek, Liu Yimin, and Zhang Jianshi (1993) conducted detailed socio-historical investigations of herders in the Nagqu area. They not only studied the production and living conditions of herders but also explored the historical changes, cultural traditions, and social structures related to herding in that area, providing a more in-depth understanding of the herding community in Nagqu (Gelek et al., 1993).

Nan Wenyuan (2000) studied the harmonious relationship between Xizang livelihood modes and the natural environment. He analyzed how traditional livelihood modes in Xizang, including animal husbandry, were adapted to the natural environment and how they maintained a relatively harmonious coexistence, which was of great significance for sustainable development in Xizang (Nan, 2000).

Gelek (2006) conducted research on the pre-liberation nomadic tribal society of the Sertar grassland in Sichuan. Although located in Sichuan, this study is relevant to the overall research on nomadic animal husbandry in the region. It provides insights into the social organization, production patterns, and cultural characteristics of pre-liberation nomadic tribes, which can be compared and referenced for similar research in Xizang (Gelek, 2006).

Guo Jiaji (2006) elaborated on the utilization of natural pastures in the vertical animal husbandry system of Diqing Prefecture, Yunnan. His research focused on how the unique vertical geographical environment in Diqing was used for animal husbandry, including the seasonal movement of livestock, the management of different types of pastures at different altitudes, and the overall efficiency of natural pasture utilization (Guo, 2006).

Shao Kan and Tian Hong (2011), as well as Luo Kanglong (2014), explored the role of traditional Xizang livelihoods in protecting the ecological environment of the Yellow River source region. They analyzed how long-established traditional livelihoods, especially those related to animal husbandry, had a positive impact on maintaining ecological balance and environmental protection in the Yellow River source area, highlighting the importance of traditional practices in ecological conservation (Shao & Tian, 2011; Luo, 2014).

Qiang Ge (2013) proposed that animal husbandry operations in Xizang agricultural areas can be categorized into four models. His categorization was based on a comprehensive consideration of various factors such as production scale, management methods, and market orientation, which provided a clear framework for understanding and analyzing the diversity of animal husbandry operations in Xizang agricultural areas (Qiang, 2013).

Existing research in the field of animal husbandry can be broadly and comprehensively classified into four distinct categories. The first category pertains to the historical context of animal husbandry production, which delves into the long-standing background, development trajectories, and the various factors that have influenced the emergence and evolution of animal husbandry over time. The second category focuses on the content of animal husbandry activities, covering aspects such as the different types of livestock raised, daily management operations, and the production processes involved. The third category is concerned with the rationale and practices of integrating agriculture and animal husbandry. This includes understanding the theoretical basis behind the combination of these two sectors and the practical methods employed to achieve a harmonious and efficient coexistence between them. The fourth category examines the coupling relationship between animal husbandry practices and environmental conservation, exploring how animal husbandry can be carried out sustainably without causing excessive harm to the environment.

While the existing literature extensively and thoroughly discusses animal husbandry production in pastoral areas , with in-depth analyses of the unique characteristics, challenges, and opportunities in those regions, studies on animal husbandry in agricultural areas remain relatively insufficient. There is a significant gap in research when it comes to understanding the specific circumstances and issues faced in agricultural areas. Particularly under the current condition of severe fodder scarcity in agricultural areas, where the availability of feed for livestock is a pressing concern, there is a lack of detailed description and specific analysis regarding the core issue of how to effectively manage and sustainably utilize local forage plant resources. This gap hinders the development of appropriate strategies for improving animal husbandry in these areas.

This paper aims to closely examine the utilization and management wisdom of forage resources in agricultural areas of Xizang. It takes as a case study the mountain pastures, cultivated grassland vegetation, and rotational grazing practices within the village domain of Zhaxilin Village, Zhanang County, Xizang Autonomous Region. The mountain pastures in this area have unique ecological features and forage availability patterns. The cultivated grassland vegetation is an important part of the local forage supply system, and the rotational grazing practices are designed to optimize the use of available forage resources. The materials presented herein were primarily derived from the author's in-depth field investigations conducted in Zhaxilin Village. These investigations involved long-term observati ons, interviews with local herders, and data collection on various aspects of forage utilization and management in the area.

2. Overview of the Field Site

Zhaxilin is a specific location that is situated in Jiru Township, which is part of Zhanang County in the Xizang Autonomous Region. Zhanang County holds a significant position as one of the 35 agricultural counties in Xizang. Moreover, it ranks among the top ten grain production bases in the region. This county is strategically located in the central - southern part of Xizang. To its east, it shares its borders with Nedong and Qonggyai counties. Towards the west, it neighbors Gonggar County. In the south, it is adjacent to Tso - me and Nagarzê counties, and to the north, it has a border with Dagzê County. The mighty Yarlung Zangbo River, which is of great geographical and ecological importance, flows from the west to the east right through the center of the county. This river divides the county into two parts, the southern and northern banks, which are roughly equal in terms of area.

When it comes to the climate, Zhanang County falls within an arid to semi - arid region. The amount of precipitation it receives is quite limited. On an annual average, it only gets about 377 millimeters of rainfall. What's more, this limited precipitation is concentrated very heavily between the months of June and August. In fact, the rainfall during these three months accounts for a staggering 74.1% of the total yearly precipitation. The area is also characterized by frequent windy conditions. From November to April, the region is dominated by westerly winds. These westerly winds bring about a dry season as they carry little moisture. From June to September, the southwest monsoon takes over and prevails in the area. This southwest monsoon is responsible for bringing the rainy season to Zhanang County. During the remaining months, which act as transitional periods, there is an alternation between the westerlies and the southwest monsoon. The continuous and persistent windy conditions in the area have a significant impact on the climate. They exacerbate the process of evaporation, which in turn further intensifies the already dry atmosphere in the county.

Zhaxilin Village is precisely located in the middle - upper section of Zhanang Gully, which is prominently situated on the southern bank of the majestic Yarlung Zangbo River. This particular gully has a significant geographical expanse, stretching as far as 25 kilometers from the northernmost point to the southernmost point. Along its entire length, the well - known County Road No. 304 traverses the gully, serving as an important transportation artery in this area.

At the lower end of the gully, one can find Zhatang Town, which holds the crucial status of being the seat of the county government. It is a distance of 17.6 kilometers away from Zhaxilin Village. This distance might seem relatively short in some contexts, but in the geographical and cultural landscape of this region, it has its own unique significance . On the other hand, at the upper end of the gully lies Shabunu Village, which is 7.4 kilometers away from Zhaxilin. This distance also forms an important part of the local spatial relationship.

The Zhangba River, which has its origin near Shabunu Village at the very head of the gully, follows a distinct path. It flows steadily from the southern direction towards the northern direction, passing through the western part of Zhaxilin. Along its course, it influences the local ecosystem and provides water resources for the surrounding areas. Eventually, after a long journey, it converges with the mighty Yarlung Zangbo River at Zhatang Town, contributing its waters to the larger river system and playing an important role in the overall hydrological cycle of the region.

Flanking the Zhangba River valley on both sides as it passes through Zhaxilin Village, there stand two remarkably prominent mountains. These mountains are well - known to the villagers, who have named them East Mountain and West Mountain based on their respective positions. East Mountain is quite imposing, being characterized by its large mass. It has a relative height that exceeds 650 meters, and its gradients are relatively gentle. The soil on this mountain is comparatively moist. There are several small springs scattered across its slopes, and in some areas, there is a slight seepage of groundwater. These factors together provide extremely suitable conditions for the growth of forage. During the winter season, a light layer of snow accumulates on the summit of East Mountain. However, the amount of meltwater generated from this snow is rather limited. For those who wish to ascend from the foothills to the summit on foot, it requires more than four hours of arduous walking.

On the other hand, West Mountain is smaller in size. It has a relative height of approximately 400 meters, and its terrain is steeper compared to East Mountain. A large part of the bedrock on West Mountain is exposed. The soil here is dry, and as a result, the vegetation is sparser when compared to that on East Mountain. The distance between the foothills of East Mountain and West Mountain is such that it takes roughly about 12 minutes to walk from one to the other.

Zhaxilin Village is a settlement where the majority of the population is Tibetan. It is composed of 84 households, with a total population amounting to 502 people. The local community mainly engages in agricultural activities. The cultivated area in the village is 809 mu. The farmland is mainly distributed on the alluvial fans at the foot of East Mountain. There is also a smaller portion of the farmland that is located on the western foothills. The traditional cropping systems in the village focus on crops such as highland barley, potatoes, peas, and rapeseed.

In addition to agriculture, animal husbandry serves as a supplementary means of livelihood for the villagers. The village has approximately 8,000 mu of grassland. This grassland is primarily used for raising dairy cattle, crossbred yaks (pian niu), sheep, and horses. However, the low precipitation in the area leads to sparse vegetation on the grassland. This, in turn, results in a low livestock - carrying capacity. In 2009, the livestock inventory in the village included 80 dairy cattle, 20 crossbred yaks, 300 sheep, 7 horses, 2 yaks, and 2 donkeys. By 2012, the numbers of these livestock had changed. There were a total of 260 dairy cattle and crossbred yaks, 264 sheep, 16 horses, 3 yaks, and 2 donkeys.

3. Utilization and Management of Vegetation in Mountain Pastures

Forage grass is truly the lifeline of animal husbandry as it provides the essential nourishment for livestock to grow, develop, and thrive[14]. In the agricultural areas of Xizang, mountain pastures play a crucial and irreplaceable role, serving as the primary grazing grounds where animals can freely roam and graze. These mountain pastures offer a natural and spacious environment for the livestock. In Zhaxilin Village, these precious pastures are concentrated on East Mountain and West Mountain. From the very foothills, where the soil is rich and fertile, to the lofty summits that seem to touch the sky, there is a wide variety of naturally growing vegetation that is highly suitable as forage. This includes Setaria glauca (Golden Bristlegrass), which has fine and nutritious blades, Avena fatua (Wild Oat) with its rich - flavored grains and stems, Brassica rapa (Field Mustard) that adds a bit of pungency to the diet, and local plants like Chamma, Ritsa, Rampa, and Pangtsa, among others. Each of these plants has its own unique nutritional value and growth characteristics.

To enhance both the efficiency and sustainability of forage utilization, the villagers in Zhaxilin Village practice comprehensive management of mountain pasture resources. They understand that proper management is the key to ensuring the long - term viability of the pastures and the well - being of their livestock. Key measures include herd separation, vertical spatial layering of grazing areas, and rotational movement between the two mountains within the village territory.

Herd separation involves grazing different types of livestock in distinct areas of the pasture. In Zhaxilin, villagers commonly separate cattle, sheep (including both goats and sheep), yaks, and horses during grazing. This practice is based on the shared behavioral traits among animals of the same species, including similar foraging strategies and survival modes. For example, animals of the same species tend to move together, have similar preferences for food sources, and respond to environmental changes in a similar way.

Cattle are the most selective in terms of forage quality. They are extremely picky eaters and prefer the freshest and most tender grass tips. They have a hard time efficiently utilizing coarse vegetation because their digestive systems are not well - adapted to breaking down tough and fibrous plants. Sheep have flexible lips that allow them to

graze close to the ground. They have a great fondness for soft and delicate grass tips from families such as Poaceae and Fabaceae. These grasses are not only easy for them to chew but also provide the necessary nutrients for their growth and development. Goats have a broader dietary range. In addition to grasses, they prefer young shoots, leaves, and bark from shrubs and trees. This ability enables them to consume plants that other livestock usually avoid, making them more adaptable to different pasture conditions. Yaks mainly feed on tall sedges and grasses. They graze on the upper parts of higher vegetation, using their tongues to wrap and pull plants. Their foraging behavior is quite rough, and as they move around the pastures, they cause significant trampling damage to the pastures, which is an important factor to consider in pasture management.

If the practice of mixed grazing were to be implemented, various types of livestock would engage in competition for the most palatable and high - quality forage available in the pasture. For instance, they would all be vying for those tender grass tips that are not only delicious but also rich in nutrients. This intense competition would inevitably lead to overgrazing of these preferred plant species. Once overgrazed, these plants would struggle to recover because their growth cycles would be severely disrupted. The continuous removal of the most desirable parts of the plants would prevent them from photosynthesizing effectively and storing enough energy for regrowth. As a consequence, the botanical diversity of the pasture would gradually decline. There are many less palatable plant species in the pasture that are often avoided by the animals. With the focus of the livestock on the more appealing forage, these less - favored plants may end up being underutilized. More critically, with the reduced grazing pressure on these less desirable plants, they gain a significant competitive growth advantage. They can grow without being constantly nibbled on, and may spread more rapidly, potentially becoming the dominant species in the pasture. This shift in the plant composition is a key driver of grassland degradation as it disrupts the natural ecological balance of the area.

Furthermore, it is important to note that certain livestock intestinal parasites are species - specific. Under mixed grazing conditions, these parasites can be spread through the fecal contamination of the pasture. When different types of animals graze in the same area, they may come into contact with the feces of other species that contain parasites. This increases the risk of cross - infection among different animal types. Herd separation is an effective measure to address this issue. By separating the herds, the parasite life cycle is effectively disrupted. Parasites that are specific to one species cannot easily infect another species when the animals are kept apart. This separation reduces the overall incidence of diseases in the livestock population. With fewer diseases, there is also a minimized need for veterinary drugs, which not only saves costs but also helps maintain the ecological health of the pasture by reducing the chemical input into the environment.

The second strategy employed by the Zhaxilin villagers for the management of mountain pasture vegetation is vertical layered grazing. Mountain pastures generally have a distinct vertical structure and are usually divided into three main vertical zones: the upper zone, the middle zone, and the lower zone. Vertical layered grazing is a well - thought - out approach that involves assigning different types of livestock to distinct elevation levels during the same grazing period. The common practice of this strategy is as follows: Cattle are allocated to the lower slopes of the mountains, which include foothill areas and even riverbanks. These areas provide the kind of environment that cattle prefer. Sheep and goats are assigned to the mid - elevation pastures, where the vegetation and environmental conditions are more suitable for their grazing habits. Yaks, on the other hand, are placed on the upper slopes, which can withstand the harsher conditions there. Horses have a more flexible grazing area; they may graze either in the lower areas or on the mountain summits depending on various factors.

Vertical layered grazing is based on the varying cold resistance and terrain adaptability of different livestock species. Cattle have specific environmental preferences. They prefer warm and humid conditions as their bodies are not well - adapted to cold weather. They are cold - sensitive and have low resilience to snow disasters. In addition, cattle are relatively clumsy in movement. They struggle on steep slopes because their large size and body structure make it difficult for them to maintain balance. On steep slopes, they are more likely to have accidents such as slipping or falling. Therefore, they prefer flat, warm river valleys or gentle slopes where they can move around more easily. In Zhaxilin, cattle are generally grazed in areas below the Duirong Temple on East Mountain and in the middle - lower sections of West Mountain. Particularly, along the Zhangba River banks, the vegetation is lush, providing an abundant food source for the cattle.

Horses are relatively small in size compared to some other livestock. They have a preference for cool, dry climates and show less adaptability to hot and humid environments. They exhibit greater cold resistance than cattle, which allows them to be distributed at higher elevations. In certain agricultural areas, some horses are even grazed on mountain summits. However, horses have specific drinking requirements. They have a higher water intake requirement compared to some other animals. Moreover, they are very particular about water quality and avoid drinking dirty or polluted water. When the villagers manage the grazing of horses, they also take these drinking habits into consideration. As a result, horses are often pastured on small patches of grassland near the village. These areas are usually close to clean water sources, ensuring that the horses have access to the water they need.

Sheep and goats thrive in cool, arid conditions and are well-adapted to the dry climate of the Xizangan Plateau. Their upper grazing altitude limit is similar to that of yaks. With their strong legs and sharp hooves, they move swiftly, cover long distances, and are adept at climbing steep terrain. This enables them to utilize small shrubs and thorny bushes in rugged, precipitous areas—vegetation that other livestock species seldom consume. Therefore, villa gers typically graze sheep and goats on the mid-to-upper slopes above Duirong Temple on East Mountain, as well as on the middle-upper sections of West Mountain.

Yaks are remarkable creatures that possess an extremely high level of cold tolerance and are well - suited to thrive in the harsh environment of alpine grasslands. These hardy animals are accustomed to the tough conditions where they endure sleeping on the frosty ground and resting on the cold snow. They have a unique behavior of licking ice and quenching their thirst with meltwater. However, they are not as well - adapted to dry and hot climates . Their bodies have developed specific physiological characteristics over time to adapt to the plateau environment. These traits have played a crucial role in shaping their unique physiological adaptations to the challenging plateau environment.

Due to these distinct characteristics, during the summer months, the villagers have a well - thought - out grazing strategy. They primarily graze yaks on the relatively cooler upper slopes of East Mountain. Among these upper slopes, the summit is especially favored. The cooler temperatures at these higher elevations provide a more suitable environment for the yaks, allowing them to graze comfortably and avoid the heat that they are not well - adapted to.

Vertical layered grazing is an ingenious management strategy that is highly adapted to the fragile ecosystem of the Qinghai - Xizang Plateau. Firstly, this strategy works by carefully aligning the grazing practices with the foraging behavior and environmental adaptability of different livestock species. By doing so, the animals are distributed across their preferred elevation zones. This distribution achieves an optimal balance where “the land is utilized to its fullest, and the animals express their natural behaviors.” It ensures that each type of livestock can access the resourc es they need while also making the most of the available land.

Secondly, this approach enables a comprehensive utilization of vegetation resources across different elevations. On the lower, middle, and upper slopes, multiple livestock types can graze simultaneously. Even if the tender leaves of a plant are consumed by the grazing animals, the continuous regrowth during the growing season allows for repeated utilization of these plants. This way, the vegetation resources are used in a sustainable manner, ensuring that there is a continuous supply of food for the livestock.

Thirdly, vertical layered grazing has a significant impact on the pasture area. It significantly expands the effective pasture area and helps to mitigate the problem of overgrazing caused by concentrated grazing pressure. The foraging impacts are distributed across various plant species throughout the pasture. This distribution prevents any single species from becoming overly dominant, which is essential for supporting the maintenance of a species - rich and structurally stable plant community.

The third strategy for vegetation management in Zhaxilin Village is rotational grazing between the two mountains within the village territory. The villagers of Zhaxilin firmly believe that any given livestock species should be rotated to a different grazing area after approximately two months of continuous grazing in the same space. This is done to prevent overgrazing, which can have detrimental effects on the pasture. To avoid the negative impacts of overgrazing, their solution is to implement such rotations.

Let's take a closer look at some characteristics of rotational grazing in this agricultural area, using cattle and sheep in Zhaxilin Village as examples. First, let's focus on the rotation of sheep.

During the months of December, January, and February, sheep are grazed on the middle - upper slopes and summit of West Mountain. West Mountain has some unique geographical features that make it an ideal grazing area during winter. As the sun - facing slope, it receives sunlight earliest in the day. This early sunlight causes the temperature on the mountain to increase more rapidly compared to other areas, and it remains relatively warmer locally. Moreover, since westerly winds prevail in Zhaxilin during winter, the middle - upper slopes of West Mountain lie on the leeward side. This provides the sheep with shelter from the strong winds, protecting them from the cold and harsh weather conditions. On calm days, when the weather is more favorable, the sheep may also be taken to the mountaintop to utilize the forage available there.

It is interesting to note that the villagers generally avoid grazing the middle - upper slopes and summit of West Mountain during summer. They have a long - term plan in mind. Grasses such as Zaga, which grow during the summer, are preserved for winter feeding. This ensures that there is an adequate supply of food for the sheep during the colder months when the growth of vegetation is limited. By the time the sun sets and the temperatures drop sharply, the sheep have already been safely returned to their pens. This practice differs significantly from the pastoral area approach of “grazing at lower elevations in winter,” as the villagers here take advantage of the unique g eographical and climatic features of West Mountain.

March and April: Sheep are moved to the foothills of West Mountain, the foothills of East Mountain, and uncultivated farmland for grazing. During this period, the sheep feed on forage such as Zaga and Chabasi. Westerly winds still prevail at this time, and as East Mountain is the windward slope, grazing there is avoided to prevent the sheep from being blown away. Additionally, temperatures remain lower at higher elevations where forage grasses have only just begun to sprout.

May, June, and July: Sheep are grazed on the middle-upper slopes of East Mountain. As the weather grows warmer, grasses such as Pangtsa and Ritsa have sprouted. By mid-June, the rainy season begins, and forage enters its peak growth period. In the past, to maximize grazing time, shepherds and their flocks would remain on the mountain throughout these three months, spending nights in mountain sheepfolds. While these folds are no longer used today, shepherds now bring the sheep up one hour earlier and return one hour later to ensure the animals are fully fed. During these months, sheep are not taken to the middle-upper slopes or summit of West Mountain. Accessing West Mountain requires crossing field ridges, and with crops in their peak growth stage, the large and fast -moving flock is difficult to control and could damage the plants. Additionally, the Zhangba River begins to swell, and the sheep—with their thick wool and short legs—fear water, making river crossing difficult. By leveraging these con ditions, the people of Zhaxilin have established the middle-upper slopes and summit of West Mountain as winter pas tures, and the middle-upper slopes of East Mountain as summer pastures for their sheep.

August and September: After the autumn harvest, both cultivated fields and wetlands become available for grazing sheep. Regardless of which household owns the land, these areas may be utilized. While feeding on the remaining vegetation, the sheep also help control weeds, and their droppings and urine naturally replenish organic matter in the soil.

October and November: Winter wheat is sown in Zhaxilin Village between October 4th and 15th. Grazing is prohibited in fields planted with winter wheat, while all other fallow land during the winter period remains available for grazing.

Now, let us consider the rotational grazing of cattle and crossbred yaks. From after the autumn harvest until before the spring sowing, cattle and crossbred yaks are primarily grazed in the area below Duirong Temple on East Mountain and east of the Zhangba River, including winter fallow fields. During May, June, and July, when sheep are moved to East Mountain for grazing, the cattle and crossbred yaks are shifted mainly to the riverbanks west of the Zhangba River and the mid-to-lower slopes of West Mountain. With their long legs, the cattle are unbothered by the rising river water. Each time they are taken toward West Mountain, the cattle and yaks grow visibly excited, attempting to outpace the herder, driven by the knowing that crops grow in the fields below the slopes, which they are eager to sneak a bite of. Before heading to West Mountain, the villagers employ countermeasures: they station people near the fields in advance, ready to intercept, thus thwarting the animals' plans. This recurring drama of "sne aking a bite" versus "preventing the sneak" adds a lively touch to cattle herding in Zhaxilin. The villagers rarely drive cattle to the mid-upper slopes of West Mountain, as that area is reserved as winter pasture for sheep. Only occasiona lly do children, caught up in the moment, herd the animals higher and higher—sometimes even reaching the summit. From late July until the autumn harvest, cattle are grazed along the field ridges, making use of the grasses growing t here, while crossbred yaks continue to be pastured on West Mountain.

The rotational grazing practices between East and West Mountain in Zhaxilin demonstrate a consistent effort by villagers to avoid simultaneous grazing of cattle and sheep in the same area. The specific timing and location for grazing each type of livestock are determined by mountain topography and animal behavior. Rotational grazing is a traditional pastoral strategy employed by Xizang communities to optimize pasture use. Gelek, Liu Yimin, Zhang Jianshi, et al. categorized pastoral migration in grazing areas into three forms: the Domar style, the Aba style, and seasonal transhumance—each representing a distinct form of rotational grazing. Traditional Xizang pastoral sayings such as:

"In summer, herd high on the mountains; in spring and autumn, return to the mid-slopes; in winter, drive the an imals to the plains."

"Summer pastures are high on the peaks, autumn grazing on the slopes, winter and spring in the flat meadows."

"Graze the shaded slopes first, then the sun-facing slopes."

These empirical summaries also embody the essence of rotational grazing. Through this system, the vegetation on East and West Mountain is alternately rested, while cultivated land (including field ridges) serves as temporary or transitional pasture. This allows full use of grasses on arable land, extends the rest period for mountain pastures, reduces grazing pressure on both slopes, and enhances the protection and sustainable use of limited forage resources.

The villagers divide the grazing area into three distinct zones based on elevation: the mountain summit, the middle-upper slopes, and the lower slopes and foothills, each designated for different types of livestock. The summit of East Mountain, being the highest area, is used for grazing yaks. With the decline in yak numbers, villagers have also begun to pasture horses there. The middle-upper slopes of both East and West Mountain, as well as the summit

of West Mountain, serve as grazing areas for sheep. Sheep move quickly, are skilled climbers, and readily feed on both fallen and growing leaves of small shrubs. The lower slopes and foothills of both mountains, along with riverbank areas, form the lower grazing zone, used mainly for cattle and crossbred yaks. Horses are often pastured on grasslands along County Road No. 304. In terms of seasonal timing, the general principle is that during the warm season, livestock primarily utilize the higher-elevation vegetation on the summits and middle-upper slopes. In the cold season, they rely more on lower-elevation forage on cultivated land, riverbanks, and foothills. A more specific guideline is to avoid overlapping grazing of cattle and sheep on the same mountain within the same period whenever possible.

4. Utilization and Management of Vegetation on Cultivated Land

The term “vegetation on cultivated land” specifically refers to all the plants that are growing on the aforementioned 807 mu of farmland. This farmland, with its fertile soil and suitable growing conditions, provides a habitat for a diverse range of plant life. This primarily includes oats, which are well - known cereal crops, and volunteer rapeseed seedlings that emerge and grow during the fallow period. The fallow period is a time when the land is given a break from intensive cultivation, allowing these volunteer plants to take root. Additionally, there are various weeds such as Setaria pumila (Golden Bristlegrass), which are common in agricultural areas, as well as grasses that grow on the ridges and edges of the cultivated plots. These ridges and edges often have slightly different soil and micro - climate conditions, which support the growth of these grasses.

During the winter fallow period in Zhaxilin Village, which extends from after the autumn harvest until the following spring sowing, livestock such as cattle, sheep, and horses are permitted to enter fields that were not sown in autumn to forage on the naturally growing vegetation. This is a long - standing practice in the village. After the autumn harvest, the fields that are left fallow are filled with a variety of plants that can serve as food for the livestock. Although the farmland has been contracted to individual households since the 1980s, the fallow plots remain open to all village livestock. This practice is sustained for several reasons. Firstly, grazing helps control weeds. The livestock consume the weeds, preventing them from overgrowing and competing with future crops for nutrients, water, and sunlight. Secondly, it enriches the soil through animal manure. The manure left by the livestock contains essential nutrients that can improve the soil fertility. Thus, after the harvest, it has long been the customary practice for villagers to let their animals graze plot by plot before beginning the plowing process. This way, the land is both cleared of unwanted vegetation and enriched with nutrients for the next growing season.

Beginning with the spring sowing in April, a comprehensive grazing ban is strictly enforced across all cultivated land in Zhaxilin Village. This ban applies not only within the fields but also on the field ridges. The main purpose of this ban is to protect the newly sown crops from being consumed or damaged by animals. At this stage, the crops are very vulnerable, and any damage can significantly affect their growth and development. By implementing this ban, the villagers create favorable conditions for the normal growth of the crops. This measure aligns with the traditional practice of “protecting young crops” (hu qing). However, unlike the strict enforcement in Zhaxilin, many rural areas in inland China adopt a more flexible approach to "hu qing". In these areas, grazing on earthen or field ridges is often considered acceptable as long as the livestock do not directly consume the crops themselves. This shows that different regions have different ways of balancing livestock grazing and crop protection based on their local conditions.

Each year from mid - to - late July until before the autumn harvest, a partial lifting of the grazing ban is implemented on the field ridges adjacent to cultivated land in Zhaxilin Village. This "partial lifting" comes with three specific provisions.

The exact start date for ridge grazing is a topic of discussion among the villagers during a community meeting. The villagers gather to share their opinions and experiences based on the growth of the crops and the availability of forage on the ridges. Then, the village committee officially determines the start date based on the collective input. For example, in 2013, ridge grazing was permitted starting from July 30. This careful determination of the start date ensures that the grazing does not cause any harm to the crops.

Grazing is allowed only during specified hours each day. Typically, the permitted time is from 10:00 AM to 1:00 PM. This limited time frame is set to further minimize the risk of the livestock straying into the fields and damaging the crops. It also takes into account the daily activity patterns of the livestock and the farmers' management convenience.

Only cattle are permitted to graze on the ridges; all other types of livestock remain excluded. Cattle are selected for this limited grazing because they are relatively easier to control compared to other livestock, and their grazing behavior is more predictable.

To prevent cattle from grazing on the crops adjacent to the field ridges, it was stipulated during the village meeting that if a cow is found consuming crops, a fine of 30 RMB yuan per animal per incident will be imposed. Village cadres are given the responsibility for supervision and issuing fines. They keep a close eye on the grazing cattle to ensure compliance with the rules. The collected funds from the fines revert to the village collective as public property. The cadres are required to maintain clear records of the fined individual's name, the time of the incident, an d the fine amount. These records are subsequently announced during village meetings to ensure transparency and to deter other villagers from allowing their cattle to damage the crops.

The utilization of ridge vegetation in Zhaxilin Village reflects a profound ecological wisdom. In terms of timing, by mid - to - late June each year, the stored straw from the previous year is largely consumed by the livestock. As the livestock have been relying on this stored straw for food during the winter and early spring, the supply gradually runs out. Meanwhile, the grasses on the field ridges grow increasingly lush due to the favorable weather conditions and the natural cycle of plant growth. However, the grazing ban cannot yet be lifted at this stage. This is because the crops are at their peak growth period, looking lush and green. If cattle were allowed on the ridges at this time, they would be more likely to prefer to feed on the crops rather than the grasses. Crops that are grazed, even if they manage to continue growing, often face problems. They may fail to flower properly, form ears, or pod, which directly impacts the yield. This shows that the villagers' management of grazing and crop protection is based on a deep understanding of the ecological relationships between the livestock, the crops, and the natural vegetation.

By the middle to the latter part of July, a significant change occurs in the overall situation. The highland barley and wheat crops gradually enter the crucial grain - filling stage, during which the grains within the ears are steadily developing and accumulating nutrients. Meanwhile, the rapeseed plants reach the podding phase, where the pods start to form and grow. In this period, if livestock happen to nibble on a few leaves of these crops without causing any damage to the stems or the ears, generally speaking, it will not have a negative impact on the normal development of the grains or the pods. Moreover, at this time, most students are on their summer break. With more free time on their hands, they can offer a helping hand in the herding process. If the grazing ban is lifted at a later time, the villagers will be extremely busy with the harvesting work. Their days will be filled with the tasks of gathering the ripe crops, leaving them with absolutely no time to focus on herding the livestock. Additionally, considering the current shortage of fodder, leaving the fresh and abundantly available green forage that grows on the ridges completely unused would be a waste from an economic perspective. It also doesn't make logical sense as this forage could be a valuable resource for the livestock.

Regarding the duration and the specific timing of ridge grazing, the villagers have their own well - thought - out and reasonable rationale. If the grazing period is set too short, the cattle will not be able to consume enough food to meet their nutritional needs. They will remain hungry, which can affect their health and growth. On the other hand, if the grazing period is too long, it will conflict with the midday milking schedule of some households. The milking process is a regular and important task for these families, and any disruption can cause inconvenience and potential losses. After a comprehensive and in - depth consideration of various factors, the villagers have deemed that a three - hour grazing period is the most optimal choice.

From a management perspective, having fixed grazing hours offers several advantages. Firstly, it allows village cadres to allocate specific time slots for patrolling along the ridges. They can monitor the grazing situation, ensure that the livestock are not causing excessive damage to the crops, and maintain order in the grazing area. Secondly, it facilitates mutual supervision among the herders. They can keep an eye on each other's livestock and report any improper behavior. It is said that the village once set the grazing period from 7:00 to 10:00 in the morning. However, when the villagers led their cattle, which were still half - asleep and drowsy, to the ridges, they noticed that the animals were very reluctant to graze. The main reason behind this was the low temperature during that time of the morning. There was also an abundance of rainwater or dew on the grass. If the cattle consume this wet grass, it can easily cause diarrhea, which is harmful to their health. This real - life case vividly illustrates how the production wisdom of the villagers is derived from direct practical experience. Through continuous comparison and adjustment in the actual practice of herding and crop - growing, they develop a more reasonable understanding of the grazing system. This understanding can then be sustained over time and passed down from one generation to the next.

Regarding livestock access to the field ridges, Zhaxilin Village has a clear rule that only cattle are permitted to graze there. This rule is not a new innovation specific to Zhaxilin. Historical records also indicate that in summer, in similar agricultural areas, no livestock other than dairy cattle are allowed to graze in the fields. Here, it should be noted that "dairy cattle" specifically refers to cattle.

Why are only cattle permitted? Cattle are of great importance to the villagers as they are the main source of milk. Milk is an essential ingredient for producing butter tea, which is a staple beverage in their daily lives throughout the year. However, livelihood is not the sole reason for this rule. There is also a crucial consideration for safeguarding agricultural production. If larger animals like horses were allowed to graze on the ridges, it would be extremely difficult for the herders to prevent them from nibbling on the valuable crops. Horses have a larger appetite and are

more powerful, making it challenging to control their movements. Smaller animals such as sheep are also excluded from ridge grazing. Sheep move quickly and are often kept in relatively larger numbers. This makes them even more difficult to manage and control, increasing the risk of them causing damage to the crops.

Cattle, in stark contrast to some more aggressive and wild - tempered animals, are relatively docile in nature. This docility is so pronounced that they can be herded with relative ease, even by children. In inland China, there exists a classic and well - known saying which goes, “You can’t catch three cattle with two hands.” This saying is not meant to be taken literally but is a metaphorical expression. It implies that one person is simply unable to manage m ultiple tasks simultaneously, just as it is physically difficult to catch three cattle all at once with only two hands. How ever, in the unique geographical and cultural context of Xizang, the situation is quite different. Here, a middle - schoo l student can effortlessly herd four cattle at the very same time. This reality makes the above - mentioned metaphor l ose its cultural relevance in this particular region, as the ability to handle multiple cattle is far more achievable than what the metaphor suggests.

Some calves, despite the overall docility of cattle, can display mischievous behavior. While they are grazing in the fields, they may nudge or butt other calves around them. This kind of behavior can quickly escalate into a scuffle. If the herder does not step in and intervene promptly, this scuffle can have serious consequences. The calves may start running around wildly, trampling the nearby crops. This trampling can cause significant damage to the agricultural output, reducing the yield and potentially harming the livelihoods of the farmers. Allowing cattle access to certain areas is not because it is believed that they will never steal or damage crops. Instead, it is because they are generally easier to control compared to other livestock. In actual reality, it is an almost impossible task to prevent cattle from occasionally nibbling on the crops. The fines that are imposed in this context are not meant to be punitive for the sake of it. Their main purpose is to discourage herders from neglecting their important duty of restraining their animals and keeping them in check.

The boundary between negligence on the part of the herder and proper control of the cattle can often be quite ambiguous. It is not always clear - cut to determine whether the herder has been negligent or if the incident was an unavoidable accident. Village cadres, in such situations, typically rely on “evidence of crop consumption” as the fund amental basis for imposing fines. When there is clear and undeniable evidence, such as visible bite marks on the cro ps or the presence of the cattle in the restricted crop area, the villager who is being fined has very little room for dis pute. They cannot easily deny the fact that their cattle have caused damage to the crops.

The village regulations that govern the use and management of ridge vegetation in Zhaxilin Village carry significant socio - ecological significance. These regulations cover several key aspects. For example, the start date of the grazing period is clearly defined. This is important as it ensures that the vegetation has enough time to grow and recover before the cattle start grazing on it. The permitted hours during which the cattle can graze are also specified . This helps in maintaining a balance between the needs of the livestock and the preservation of the vegetation. Additionally, the penalties for violations of these regulations are clearly laid out. All these aspects are discussed in a democratic manner during village meetings. Every villager has the opportunity to voice their opinions and concerns. Through this democratic process, a collective agreement is formed, which everyone in the village is expected to abide by. The enforcement of these regulations relies on a fining mechanism. Although these fines may not hold legal legitimacy in a broader legal sense, they play a crucial role in upholding the shared interests of the village community. By ensuring that the regulations are followed, the smooth implementation of the vegetation management plan is made possible. Theoretically speaking, protecting every single plot of cropland in the village from livestock damage is equivalent to safeguarding one’s own family’s crops. After all, the well - being of the entire village is interconnected. Moreover, the fining process is completely transparent. Whenever someone is fined, all the details, including who has been fined and how much the fine is, are announced publicly. This ensures that all the vill agers are well - informed and can hold each other accountable. Finally, the fines are collected from the villagers and are used for the benefit of the villagers themselves. As part of the village collective funds, they are used to support va rious public welfare projects. These projects can range from building better irrigation systems to improving the loca l roads, from which every single villager in the community benefits.

The utilization of vegetation on the cultivated land in Zhaxilin Village not only signifies a spatial expansion in the scope of forage resources but also represents a temporal advancement in the way these resources are used. This is not just a simple change; it is a well - thought - out and proactive strategy that the villagers have adopted in direct response to the shortage of fodder. By making use of the vegetation from the croplands, it partially alleviates the heavy pressure on households to store a sufficient amount of feed. Moreover, it reduces the grazing pressure on the non - cultivated pastures. This reduction in grazing pressure on non - cultivated areas allows the vegetation there to grow more vigorously and healthily. As a result, these non - cultivated areas indirectly serve as a valuable reserve of forage for livestock during the harsh winter and spring seasons. In this particular sense, the farmland in the agricultural areas of Zhaxilin Village functions as a temporary or transitional pasture, providing an alternative source of food for the livestock when needed.

On the other hand, in these areas, animal husbandry still remains subordinate to agriculture. This means that all the productive actions and measures taken by the villagers are implemented with the top priority of safeguarding agricultural production. The villagers understand that the stability of agriculture is the foundation for their overall livelihood, and thus, any activities related to animal husbandry are carefully planned and carried out to ensure that they do not harm the agricultural production.

Utilizing the farmland as a temporary or transitional pasture during the winter fallow period challenges the rigid and traditional theoretical dichotomy of “suitable land for farming, suitable land for herding.” In actual practice, the v egetation on the cultivated land plays a crucial and irreplaceable role in fattening and conditioning the livestock. It pr ovides the necessary nutrients for the livestock to grow strong and healthy. At the same time, it significantly reduces the grazing pressure on the mountain pastures. This reduction in pressure enables rotational grazing, which is an im portant method for the proper management of pastures. It also supports the orderly utilization of vegetation resourc es within the territory of the village, ensuring that these resources are used in a sustainable and efficient manner.

5. Conclusion

Several important insights can be derived from the local strategies of forage resource utilization and management in pastoral production in Zhaxilin Village. First of all, the spatiotemporal arrangement of grazing on the East and West Mountains reflects the villagers' profound understanding and active management of the forage growth characteristics, the natural environment, and the distinct behaviors of different livestock species. Regarding the forage growth patterns, the villagers have developed a well - structured rotation system. They rotate the grazing areas approximately every two months. This rotation is a carefully calculated measure to prevent overgrazing, which could lead to the degradation of the pastures and a decrease in forage quality. In terms of the natural environment, a wide range of factors are carefully considered. These include elevation, terrain openness, wind direction, sun exposure, and moisture availability. A clear and vivid example is the differentiated use of the East Mountain as a shaded slope and the West Mountain as a sun - facing slope during different periods. The East Mountain, with its shaded environment, may be more suitable for grazing at certain times when the livestock need a cooler place, while the West Mountain, with more sun exposure, can provide warmer and drier conditions at other times. The adaptation to livestock behavior is also very evident. It is manifested in the practice of herd separation, where cattle, sheep, and horses are grazed separately. Additionally, there is a strategic placement of different livestock on different slopes. Yaks are typically placed on the upper slopes, sheep on the mid - slopes, and cattle on the lower areas. This placement takes into account the different feeding habits and physical characteristics of these animals.

Second, a distinctive feature of animal husbandry in agricultural areas is the management and utilization of vegetation within the cultivated land. Maximizing the use of such vegetation is a very effective way to reduce the pressure on the pastures in mountainous areas, riverbanks, and other natural grasslands. By reducing the grazing pressure on these natural areas, it allows them to recover and rejuvenate. This recovery creates favorable conditions for their sustainable use in the long run. However, the core challenge in utilizing the vegetation on the farmland lies in finding the right balance between its exploitation and the protection of crops during their growth period. In Zhaxilin Village, the lifting of the grazing ban on field ridges is governed by a series of institutional arrangements. These arrangements cover aspects such as timing, duration, and the types of livestock that are permitted to graze. These arrangements have been formalized as “village regulations” and are collectively observed across the entire co mmunity. These regulations play a crucial role in standardizing the orderly utilization of ridge vegetation by all the vil lagers, ensuring that the use of this resource is carried out in a fair and sustainable manner.

Thirdly, in Zhaxilin Village, both the vegetation in the mountain pastures and that in the cultivated lands are managed and utilized as communal resources. Historically, in 1981, Xizang carried out the household responsibility system for agricultural and pastoral production. As a result, the farmlands and pastures in Zhaxilin were contracted to individual households. Nevertheless, when it comes to the utilization of the vegetation in the mountains and fields, the villagers do not regard the land or pastures owned by their own households as strict boundaries that would prevent livestock from other families from entering. This kind of approach is highly beneficial as it facilitates the seamless integration of the village's vegetation resources. Moreover, it significantly enhances the efficiency of forage utilization, making the best use of the available natural resources.

Finally, the utilization and management of the high - altitude pastures in the agricultural areas have played a crucial role in expanding the villagers’ living space. In the river valley, the space available for agricultural production i s relatively limited. Facing this constraint, the villagers have cleverly turned their attention to the vegetation resource s of the East and West Mountain pastures. They have actively developed animal husbandry, aiming to achieve an integ rated agro - pastoralism model. This model not only enhances the intensity of resource use within their habitat but al so broadens and deepens the scope of resource utilization. By doing so, it provides better and more favorable conditi ons for the villagers' subsistence, enabling them to have a more stable and prosperous life.

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The author declares that he has no known competing financial or personal relationships that could have appeared to influence the work reported in this paper.

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