Lecture Notes in Education, Arts, Management and Social Science,
2026, Volume 4, Issue 7
https://bbwpublisher.com/journal/LNE
Online ISSN: 2705-053X
Print ISSN: 3083-1091

Ecological Adaptation of Pastoral Livelihoods in the Tengger Desert: An Ethnographic Case Study of Tulantai Gacha, Alxa Left Banner

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Abstract: Taking Tulantai Gacha in Hashiha Sum, Alxa Left Banner of Inner Mongolia as the field site, this study focuses on the ecological adaptation practices of herders in the hinterland of the Tengger Desert, and explores the interplay between human livelihood strategies and ecological order in an extremely arid environment. Based on ethnographic investigation and in-depth interviews, the study finds that under the dual pressures of grassland degradation and the grazing prohibition policy, local herders have reconstructed their livelihood system through flexible, diversified livelihood activities. They have developed a livestock husbandry model with a dynamic balance of "utilization and maintenance." Camel breeding, relying on largely free-range extensive strategies and ecological maintenance practices, maintains biological adaptability while alleviating ecological pressure. *Cynomorium songaricum* cultivation, as an emerging industry, reflects the capacity for cultural adaptation under environmental constraints. The study further reveals that herders have built a sustainable tripartite system of humans, livestock, and the environment through technological selection guided by practice theory and social collaboration supported by the principle of reciprocity. This case provides a new paradigm of cultural adaptation in arid regions for ecological anthropology, and demonstrates the value of human agency in traditional knowledge systems in contemporary ecological governance.

Keywords: Alxa Left Banner; Flexible livelihood strategies; Camel breeding; *Cynomorium songaricum* cultivation; Ecological adaptability

Online publication: July 26, 2026

1. Herders' modes of production in Tulantai Gacha, Hashiha Sum, Alxa Left Banner

Tulantai Gacha is located in the southwestern part of Alxa Left Banner, deep in the hinterland of the Tengger Desert. It features a typical temperate continental monsoon climate characterized by perennial aridity, scarce

precipitation, frequent high winds, sandstorms, and abundant sunshine, with an annual mean temperature of 7.4°C. The major natural hazard in the area is sandstorms, which occur more than ten times a year in high-frequency years and no fewer than five times in low-frequency years [1]. Tulantai Gacha has a permanent population of 15 households, and its unique natural geographical environment has shaped the distinctive modes of production and livelihoods of local herders.

2. Flexible livelihood strategies

Driven by institutional interventions such as the grazing-ban policy alongside ongoing grassland degradation, herders in Tulantai Gacha have diversified their income sources, displaying salient features of multi-sector livelihood operations. There are three main income streams for local herders: livestock breeding, forage and crop cultivation, and wild *Cynomorium songaricum* harvesting. Most herders engage in all three activities [2].

Livestock breeding is the primary source of income for local herders, and all 15 permanent households in Tulantai Gacha participate in it to varying degrees. The main livestock species include camels, sheep, goats and cattle, with a total stock of 598 camels, 549 sheep, 505 cattle and 51 goats. Camels are the most numerous, a pattern determined by the unique local natural geography. Endowed with exceptional tolerance to drought, cold, and sandstorms, camels are well suited to Alxa's harsh natural surroundings, rendering camel husbandry a signature local pillar industry. Herders generate income mainly by selling camel calves, fattened camels, camel milk and camel hair products. These activities constitute their principal source of revenue. Unlike cattle and sheep, camels are rarely raised for meat consumption among local residents and serve purely economic purposes.

After camels, sheep and cattle are the most widely raised livestock. Like camels, sheep and cattle are mainly monetized through the sale of meat and hides. A key distinction lies in the fact that beef and mutton form staples of local household diets, so a substantial share is retained for domestic consumption. A small number of herders also raise pigs, but in very small numbers and mainly for self-consumption. Only one household in Tulantai Gacha raises 16 pigs, mostly for consumption by the family and relatives, with a small portion sold.

Across all 15 surveyed households, livestock-related income accounts for over 80% of total household revenue; for some herders, this proportion exceeds 95%. Households engaged in camel husbandry achieve an annual household income ranging roughly from 200,000 to 300,000 RMB, whereas households without camels earn approximately 100,000 RMB per annum. This is a direct reflection of the ecological adaptability of local livelihood patterns.

Agricultural cultivation is another important income source for herders and is closely integrated with animal husbandry. The main cash crops grown locally include alfalfa, sorghum, corn, and *Cynomorium songaricum*. Alfalfa, sorghum, and corn are predominantly grown as forage for livestock. All 15 households in Tulantai Gacha maintain forage-crop plots ranging from 2–3 mu(1mu≈0.067 hectares) up to 20 mu. Cultivated land scales correlate positively with livestock herd size: households raising larger herds allocate more land to forage production. Crops such as corn grown by local herders are almost never sold; they are all used as forage for their own livestock. The economic benefits of forage cultivation for households, subject to price fluctuations, range from several thousand to tens of thousands of yuan.

Besides forage crops, a small number of herders cultivate *Cynomorium songaricum*. As a rare and valuable traditional Chinese medicinal herb, *Cynomorium songaricum* was recorded in texts as early as the

pre-Qin period and was first used medicinally in the Han Dynasty. It has long been prized by renowned physicians throughout Chinese medical history. Contemporary pharmacological research identifies abundant bioactive substances within the herb, including tannins and malonate hemiester of oleanolic acid, which confer tonic, anti-aging, and antioxidant effects [3]. *Cynomorium songaricum* typically grows in arid regions of northwestern China, where the desert climate is dry and sunny with large diurnal temperature variations—conditions suitable for its growth.

Only two households in Tulantai Gacha grow *Cynomorium songaricum*, with planting areas of 10 mu and 12 mu, respectively. Each household generates an annual income of about 100,000 yuan per household. These two households maintain the smallest livestock herds across the Gacha, so *Cynomorium songaricum* cultivation has become their largest source of income. Local informants report that, under pressures from grazing restrictions and grassland degradation, a growing number of Alxa herders have turned to *Cynomorium songaricum* cultivation as their primary livelihood. It is gradually becoming a distinctive pillar industry in Alxa alongside camel breeding.

Abundant wild *Cynomorium songaricum* also grows on local pastures. Wild *Cynomorium songaricum* has higher medicinal and economic value than cultivated varieties. Consequently, in addition to livestock-raising and crop farming, local herders harvest wild *Cynomorium songaricum* on their own pastures for sale. Every year between March and May, all fifteen households gather wild *Cynomorium songaricum* on their rangelands and sell harvested products to itinerant medicinal herb traders. Depending on the size of each household's pasture, this activity brings in between 30,000 and 50,000 RMB each year, making it an important income stream for local herders.

From the perspective of cultural change theory, environmental conditions constitute critical drivers of livelihood transformation, of which Tulantai Gacha offers an illustrative case. Located deep in the Tengger Desert, the area suffers from aridity, frequent windstorms and sandstorms, and a relatively harsh ecological environment. Originally relying mainly on animal husbandry, they have had to adjust their livelihood strategies in response to environmental changes such as grassland degradation and the grazing withdrawal policy. Moving away from exclusive dependence on livestock husbandry, they have developed new economic sectors such as *Cynomorium songaricum* cultivation. This series of transformations fully demonstrates that when natural and policy environments change, humans will proactively adjust their production and livelihoods to readapt their livelihood patterns to the new environment, thereby maintaining the stability and continuity of their cultural system.

3. Livelihood characteristics

3.1. Animal husbandry: Integrating utilization and conservation

Ecological anthropology conceptualizes humans as integral components of ecosystems, highlighting intricate interdependencies between human societies and biotic as well as abiotic environmental elements. Human survival and development draw upon the resources and services provided by ecosystems, while human activities also affect the structure and function of ecosystems.

Alxa League covers an administrative territory of 270,000 square kilometers, of which the designated desert-grassland area is about 276 million mu, accounting for 66.6% of the total land area. Grasslands here are generally subject to severe desertification, with low and highly volatile forage yields ranging from several kilograms up to 200 kilograms per mu [4]. In this unique natural environment, a delicate relationship

has formed between herders and grasslands, with the two mutually dependent and interactive. Through long-term pastoral practice, Alxa herders have accumulated practical ecological knowledge and developed pastoral systems that organically integrate grassland utilization and conservation.

In daily pastoral practice, experienced herders divide their pastures into several zones and conduct irregular on-site inspections. When vegetation within a given zone shows signs of overgrazing, livestock are relocated to alternative zones to allow the degraded plots to rehabilitate before grazing resumes. Grazing rest is sometimes implemented in areas with sparse vegetation cover. During key growth stages of forage, such as the spring green-up period and the peak summer growing season, herders voluntarily rest the grasslands and prevent livestock from grazing there. During rest periods, forage can grow and reproduce fully, improving vegetation coverage.

Meanwhile, Alxa herders also conserve grasslands by planting grasses and trees, which play an important role in soil and water conservation, wind prevention and sand fixation, and ecological restoration. Herders usually prioritize drought-resistant, cold-hardy, and sand-tolerant native species such as *Artemisia desertorum*, *Astragalus adsurgens*, *Haloxylon ammodendron,* and *Caragana korshinskii*. These taxa are well adapted to harsh desert conditions and possess extensive underground root systems reaching several meters deep, enabling efficient water and nutrient uptake while stabilizing topsoil against wind and sand erosion.

After planting, herders strengthen the management and conservation of grasslands and woodlands. They conduct regular inspections to prevent overgrazing by livestock and human-induced damage. During dry seasons, targeted irrigation is applied where necessary to satisfy plant water requirements. Pest and disease risks are closely monitored: at the first sign of infestation, they take timely control measures such as biological control, physical control, or rational pesticide use to ensure healthy plant growth.

These locally embedded practices reflect herders' sophisticated understanding of, and respect for, ecosystem dynamics. Through traditional animal husbandry methods and proactive ecological conservation efforts, they utilize natural resources while striving to maintain ecosystem balance. This human-nature co-existence model not only underpins local subsistence and socio-economic development, but also contributes greatly to local ecological stability.

3.2. Extensive free-range husbandry with supplementary human intervention

Alxa League is the largest by area but the least populated league in Inner Mongolia Autonomous Region, with a total area of about 270,000 square kilometers and a permanent population of only 268,400 [5]. Although there is no exact data on per capita pasture area, Alxa's per capita pasture area compares favorably with that of leagues such as Xilingol, where animal husbandry is highly developed. This unique land-population relationship—vast land with sparse population—has shaped the local animal husbandry model that combines free-range grazing with supplementary human intervention.

Free-range husbandry refers to an extensive production mode whereby livestock forage and move freely across natural landscapes; it is widely applied to camels, cattle, and sheep. Livestock raised under such systems are generally considered to have higher-quality meat and enjoy strong market demand. Compared with free-range husbandry in other parts of Inner Mongolia, the model in Alxa features less human intervention and a higher degree of free-range rearing.

Take camel breeding as an example. Camels exhibit extraordinary physiological adaptability and strong drought resistance. Following prolonged water deprivation, camels can replenish bodily water reserves through single large-volume drinking events: a camel can drink 10–20 liters of water in one minute and 100–

120 liters in ten minutes, accounting for one-third of its body weight. This demonstrates that camels have a much higher capacity for water compensation than other livestock [6]. Meanwhile, camels are not selective feeders: they can feed on spiny, salt-tolerant desert plants such as *Haloxylon ammodendron*, *Calligonum mongolicum,* and *Alhagi sparsifolia*, as well as plants that other livestock struggle to graze on.

Camels are gregarious animals that form herds characterized by social hierarchies and cooperative labor divisions. In free-range environments, they naturally form herds for mutual cooperation and protection. For example, when encountering sandstorms or natural enemies, herd members gather closely to cope with the threat together. Thus, camels inherently have advantages in free-range rearing. Coupled with Alxa's vast land and sparse population, these traits underpin its highly extensive camel-raising regime.

Herders attach tracking devices to lead camels within each herd and allow animals to roam and forage autonomously. Human intervention only occurs during specific periods: camels are rounded up each spring for hair shearing; in summer and autumn, the peak season for camel botfly infestation, herders go into the desert to locate and treat sick camels for both their own neighboring households; in winter, they use remotely controlled automatic pumps to provide water for the camels. Beyond these scheduled interventions, herders barely intervene in the camels' daily routines. This allows them to raise large numbers of camels while still having time to tend to other livestock or engage in other livelihood activities.

One interviewed herder raises more than 30 camels, which generate tens of thousands of yuan in annual income. In addition, he works as a truck driver, earning over 100,000 yuan annually from freight transport. He joked that his camels are "raised by Mother Nature," a remark that vividly illustrates the high degree of free-range animal husbandry in Alxa.

Besides camels, cattle and sheep husbandry in Alxa also features highly extensive free-range management. Unlike cattle and sheep farming in other parts of Inner Mongolia, herders in Alxa do not need to follow and supervise their livestock while grazing. After releasing cattle and sheep from their pens, herders let them roam and forage freely. Owing to low grassland vegetation cover, these animals travel long distances during foraging, yielding superior meat quality. This makes Alxa beef and mutton more popular among consumers, and their prices are significantly higher than those in other parts of Inner Mongolia.

It is evident from the above that Alxa League's unique geographical environment and demographic conditions have given rise to an animal husbandry model that integrates free-range grazing with supplementary human intervention. This model exhibits highly extensive free-range characteristics in the husbandry of camels, cattle, and sheep. It has not only shaped the distinctive character of local animal husbandry, but also carries rich anthropological implications.

This production model resonates strongly with practice theory, which highlights the constitutive role of practical experience in shaping social structures and cultural formations. Through long-term pastoral practice, herders have developed locally tailored free-range strategies formed by livestock biological traits and regional environmental conditions. For example, leveraging camels' gregarious nature and strong adaptability, herders raise them by installing trackers on lead camels and intervening only during specific periods. For cattle and sheep, they make use of the low vegetation coverage of local grasslands, allowing the animals to roam freely in search of forage to improve meat quality.

These practices not only form an important part of local pastoral culture, but also strengthen herders' cultural identity and cultural transmission. From a social structural perspective, this husbandry model has had a profound impact on local social relations. With free-range husbandry, households maintain nominally

independent livestock ownership yet sustain loosely structured but functionally collaborative community ties. While each household bears primary responsibility for its own animals, community members offer mutual support when confronting shared risks, such as camel botfly outbreaks or extreme weather events.

Such collaborative dynamics strengthen community cohesion and serve as an empirical instantiation of the anthropological principle of reciprocity within local social life. The reciprocity principle emphasizes mutual giving and exchange among social members to maintain the balance and stability of social relations. Mutual aid among Alxa pastoral households represents a tangible realization of this principle, underpinning harmonious community development.

Disclosure statement

The authors declare no conflict of interest.

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