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Research on the Development Path of Ecological Animal Husbandry in Yushu Prefecture under the Constraints of Grass-Livestock Balance

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Abstract: The grass-livestock balance system, as a core policy tool for grassland ecological protection, has increasingly evident contradictions with the development of animal husbandry in pastoral areas. Ecological animal husbandry plays a crucial role in addressing the conflicts between protection and development. Under the constraints of grass-livestock balance, the development of ecological animal husbandry in Yushu Prefecture faces numerous structural constraints, such as reduced ecological carrying capacity, constraints from traditional concepts, feed supply shortages, low added value in the industrial chain, and a lack of relevant supporting policies. The root cause lies in the failure of collaboration among the "nature-industry-system." This study proposes a systematic and integrated development path from three dimensions: strengthening natural foundations, enhancing industrial drivers, and improving institutional guarantees. It also demonstrates the internal mechanisms of the coordinated development paths among these three aspects, providing theoretical references for ecological protection and industrial coordinated development in ecologically fragile regions of the Qinghai-Tibet Plateau.

Keywords: Grass-livestock balance; Ecological animal husbandry; Development path; Yushu Prefecture

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1. Introduction

In the ecological barrier region of the Qinghai-Tibet Plateau, the grass-livestock balance system serves as a critical policy tool for grassland ecological protection and a stringent criterion system for reshaping pastoral development patterns. However, under such rigid constraints, deep-seated contradictions emerge, and ecological animal husbandry becomes the primary approach to addressing this dilemma. Guided by ecological considerations, it emphasizes relying on forage supply to replace dependence on natural grasslands, optimizing the output efficiency of individual livestock through industrial chain expansion, and promoting the transition of animal husbandry from quantity expansion to quality and efficiency enhancement,

aiming to achieve the dual goals of "reducing livestock without reducing income and enhancing ecological benefits" [1]. The grass-livestock balance system sets the boundary of "what cannot be done", indicating an insurmountable limit, while ecological animal husbandry provides the development direction of "what can be done", forming a coordinated relationship between the two. Yushu Prefecture, located in the core area of the Three-River Source region, exemplifies the contradiction between ecological protection and animal husbandry development on the Qinghai-Tibet Plateau. With an average elevation exceeding 4,000 meters, the ecosystem is highly sensitive and fragile. Yak populations are substantial, and animal husbandry is the primary livelihood for herders. In Yushu Prefecture, the grass-livestock balance system is strictly enforced with extensive coverage, and ecological animal husbandry is regarded as the main direction for industrial transformation. Choosing Yushu Prefecture as the research object to explore the development path of ecological animal husbandry under rigid grass-livestock balance constraints can reveal the inherent conflicts between ecological protection and industrial transformation in alpine pastoral areas and provide practical insights for similar regions in China.

2. Current status of grass-livestock balance and ecological animal husbandry development in Yushu Prefecture

2.1. Grassland resources and ecological endowments

Yushu Prefecture has a total grassland area of 210 million mu, of which 170 million mu are utilizable, accounting for 81% of the total grassland area. The prefecture is predominantly characterized by alpine meadows and alpine grasslands, with an average elevation exceeding 4,000 meters. The ecosystem has a weak self-repair capacity and is highly sensitive to grazing intensity and human activities [2]. In recent years, through the implementation of projects such as the second phase of the Three-River Source ecological protection and construction project and grazing withdrawal and grassland restoration, the comprehensive vegetation coverage of grasslands has improved from 57.46% to 62.4%, indicating a generally positive trend in grassland ecology.

2.2. Achievements in grass-livestock balance policy implementation

Yushu Prefecture has fully implemented grazing bans and grass-livestock balance systems, designating 12.436 million hectares for grass-livestock balance and grazing bans. Each year, 887 million yuan in grassland ecological reward and subsidy funds are allocated. The theoretical livestock carrying capacity is determined through dual-track control of "grazing bans + grass-livestock balance", and systems such as forage-based livestock determination, rotational grazing, and rest grazing are implemented. By 2025, the "traceability, epidemic prevention, and insurance linkage integration" project will be advanced, forming a digital supervision system covering the entire process of yak and Tibetan sheep breeding. Preliminary exploration of practical paths for "reducing livestock without reducing production and income" has been achieved [3].

2.3. Practices in ecological animal husbandry development

Yushu Prefecture aims to establish itself as a supplier of green and organic agricultural and livestock products, constructing an industrial pattern supported by "hundreds of cooperatives, with seed stock breeding, forage bases, cold chain processing, and output as pillars." Currently, 70 ecological animal husbandry demonstration cooperatives, 15 breeding bases for thousands of yaks and Tibetan sheep, and 12 improved

breed breeding bases have been established. Twenty-five provincial and prefectural leading enterprises have been cultivated, with forage planting areas reaching 430,000 mu. Cooperative dividends exceed 40 million yuan [4]. Livestock slaughter volumes have exceeded 400,000 head for two consecutive years, with annual agricultural and livestock product output values reaching over 3.4 billion yuan, and agricultural and animal husbandry added value accounting for approximately 55% of the regional gross domestic product. These achievements indicate that Yushu Prefecture has initially achieved coordinated development of ecological protection, industrial upgrading, and herder income growth while implementing grazing bans and rest grazing systems [5].

3. Realistic challenges in ecological animal husbandry development under grass-livestock balance constraints

Despite achieving phased results, the development of ecological animal husbandry in Yushu Prefecture still faces multiple structural challenges under the rigid constraints of grass-livestock balance. From a systems theory perspective, these challenges do not occur in isolation but are collectively manifested as the collaborative failure of three subsystems: "natural foundation-industry driver-institutional guarantee."

3.1. Natural foundation under pressure: Fragile ecosystem and weak element support

Numerous challenges exist in the natural foundation, including rigid constraints on ecological carrying capacity and insufficient support from the forage supply system, which coexist and interact. On the one hand, the ecological foundation is inherently fragile. The alpine grassland ecosystem in Yushu Prefecture has low productivity and nearly zero self-repair capacity. After grassland degradation, desertification, and rodent infestations, the comprehensive livestock carrying capacity of grasslands hovers near the critical threshold for extended periods, with some areas still experiencing overloading. During cold seasons, grasslands cannot supply sufficient winter and spring forage, resulting in a production pattern of "lush in summer, plump in autumn, lean in winter, and dead in spring." With ongoing climate change, fluctuations in ecological carrying capacity become more intense and harder to regulate [6]. On the other hand, the artificial support system is weak. The harsh alpine climate results in low forage production from natural grasslands. Artificial forage bases are small in scale and scattered in distribution, with low levels of improved breed promotion and mechanization, making it difficult to stably ensure yield and quality. Forage storage facilities are scarce and unevenly distributed, and the transportation and distribution system is imperfect, failing to provide stable support for semi-intensive and intensive breeding. This exacerbates the grass-livestock conflict during winter and spring. The two factors reinforce each other: the worse the forage supply, the greater the pressure on natural grasslands; the more severe the grassland degradation, the harder it is to fill the forage gap, leading to a vicious cycle.

3.2. Weak industry drivers: Traditional concepts and insufficient value chain enhancement

The industry faces numerous challenges in terms of drivers, rooted in path dependence on traditional breeding concepts and the shortness of the industrial value chain, which are interdependent aspects. Herders' adherence to the old concept of "emphasizing quantity over quality" is largely a rational response to the short industrial chain, which fails to feed back value-added benefits to the breeding sector. Conceptually, herders

have long held the mindset that "a large herd size leads to wealth" and are resistant to ecological breeding methods such as improved breed breeding and formula feeding, resulting in slow adoption of feeding technologies. Moreover, due to long-standing habits of emphasizing breeding over processing and neglecting market development, products are mostly live livestock and primary meat and dairy products, lacking brand awareness and value-added consciousness. At the industrial chain level, the processing conversion rate of agricultural and livestock products in the prefecture is approximately 46.6%, with most output sold as raw materials. The price of the same raw material can increase by 1.5 times after fine processing. However, there are a few leading enterprises with weak driving effects, making it difficult for herders to obtain value-added benefits from processing and circulation links [7]. After reducing livestock, if quantity losses cannot be compensated by improving quality, "reducing livestock without reducing income" lacks spontaneous market support. At this point, herders' rational choice is to maintain quantity growth. Traditional concepts and industrial chain deficiencies constrain each other: due to the short industrial chain, it is difficult to expect income growth after reducing livestock, further solidifying the old idea of "relying on nature for livestock." This old idea, in turn, suppresses herders' enthusiasm for industrial chain expansion, leading to transformation difficulties.

3.3. Inadequate institutional guarantees: Incentive incompatibility and lack of policy coordination

The institutional guarantee faces challenges, namely, the ineffective connection between rigid constraints and flexible support, and deviations between the reward structure of policies and grass-livestock balance goals. In terms of fund allocation, the annual 887 million yuan in reward and subsidy funds are mainly used for direct subsidies for grazing bans and grass-livestock balance, with a low proportion allocated to transformation links such as forage bases, semi-intensive breeding, and industrial chain expansion. This results in weak support for herders' transition from reducing livestock to new production methods. From the perspective of reward structure, grazing ban subsidies are only 7.5 yuan per mu per year, and grass-livestock coordination rewards are only 2.5 yuan, far below the average benefits of animal husbandry, affecting herders' enthusiasm for reducing livestock. In some areas, illegal grazing still occurs [8]. During implementation, issues such as duplicate calculations of grassland areas have occurred at the grassroots level when determining livestock carrying capacity, exaggerating the theoretical carrying capacity, and maintaining the actual overloading rate within the range of 15% to 20%. Additionally, in terms of supporting services, the coverage of animal husbandry insurance is small, the risk-sharing mechanism is imperfect, and there is a shortage of human resources for animal husbandry technical services at the grassroots level, hindering the smooth progress of industrial transformation.

4. Development path of ecological animal husbandry under the constraint of grass-livestock balance

Through the assessment of the triple synergy failure of "nature-industry-system", the design of the development path must start from the perspective of system integration, forming a synergistic development framework that integrates "solidifying the natural foundation—enhancing industrial activation—improving institutional guarantees." These three dimensions are not three unrelated matters but an interconnected and mutually supportive organic whole.

4.1. Solidifying the natural foundation: Synergistic advancement of ecological carrying capacity stabilization and forage system improvement

To solidify the natural foundation, it is essential to advance grassland ecological protection and the establishment of an artificial forage system as a whole, with the key idea of using "artificial supplementary feeding" to achieve "natural pressure reduction." On the one hand, it is necessary to adhere to the rigid boundaries of ecological carrying capacity, strictly implement grazing bans, rotational grazing, and coordinated grass-livestock management systems, accurately calculate the grass yield and theoretical stocking capacity of pastures in cold and warm seasons, decompose and reduce livestock numbers layer by layer, and assign responsibilities accordingly. Continuously promote the restoration of degraded grasslands and the remediation of black soil beaches to regrow vegetation, improve soil quality, and enhance the ecological service functions of grasslands. Monitor grassland productivity according to climate change to form a flexible adjustment mechanism, preventing grass-livestock disharmony caused by extreme weather. On the other hand, it is crucial to establish a unified forage production, storage, and distribution guarantee system, create high-quality artificial forage bases in suitable locations on a large scale, integrate scattered grassland resources, strive to overcome current obstacles in forage cultivation area, support cooperatives in building standard silage pits and hay barns, expand forage storage capacity to cover the three-month shortage in winter and spring, and improve the three-tier forage storage and distribution system at the prefecture, county, and township levels to ensure forage supply during extreme weather and dry seasons. The combined effect of these two aspects is that stable ecological carrying capacity defines the spatial scope for the establishment of forage bases, while sufficient forage storage serves as another support for the rest and recovery of natural grasslands. Artificial forage and natural grasslands buffer each other, jointly consolidating the natural foundation for the development of ecological animal husbandry.

4.2. Strengthening industrial drive: Breaking through the internal cycle of conceptual lock-in through value chain extension

Industrial drive is a key part of the trinity framework, focusing on achieving perceptible value-added results through industrial chain expansion, thereby breaking the fixed pattern of "short industrial chain-rigid concepts-difficult transformation", so that value-added benefits prompt conceptual changes, which in turn drive industrial upgrading. Firstly, create diverse development scenarios and extend the value-added chain. Yushu City, Chengduo County, and Nangqian County in the east shape efficient ecological agriculture and animal husbandry development areas, while Zaduo County, Zhiduo County, and Qumalai County in the west form high-quality beef and mutton production areas. Introduce production lines such as fine segmentation of yak meat and deep processing of by-products, enhance processing and conversion efficiency, enabling the same raw material to increase in price by more than 50% after careful processing. Secondly, rely on brand power to optimize market premiums, polish geographical indication brands such as "Yushu Yak", help small, medium, and micro enterprises obtain "three-standard" certifications, expand online and offline sales channels, connect high-end markets and order agriculture, so that herders can truly feel the income increase brought by "quality improvement and efficiency enhancement" through dividends from cooperatives. Exert demonstration and leading effects, rely on village-level cooperatives to demonstrate and promote new methods such as improved breeding, timely slaughter, and supplementary feeding and grass saving, and give commendations and rewards to those who take the lead in adopting these methods. When herders see their neighbors raising fewer livestock but earning more, traditional concepts will receive the most intuitive

driving force for change. The logical chain effect of industrial drive: industrial chain expansion generates value-added benefits, value-added benefits affect income expectations, income expectations change prompt conceptual updates, and conceptual updates drive herders to spontaneously participate in improved breeding and scientific breeding, thus forming a virtuous cycle.

4.3. Improving institutional guarantees: providing external support for industrial drive through policy synergy

Institutional guarantees serve as the "lubricant" and "stabilizer" for the continuous operation of the natural foundation and industrial drive, aiming to provide risk protection and positive influence for herders during the transformation process. Firstly, improve the reward structure of incentive and subsidy funds, changing the fund disbursement method from universal distribution to being closely linked to grassland monitoring and evaluation results. Herders with better grassland restoration and effective implementation of livestock reduction measures will receive a higher proportion of incentive subsidies, thereby encouraging herders to transform from grassland users to ecological protectors. Secondly, enhance the precision of policy implementation, use digital methods to verify grassland area and stocking capacity, prevent duplicate calculations or false verifications, limit the actual excess stocking ratio within an acceptable range, increase financial support intensity for the creation of forage bases, enclosed feeding facilities, and other transformation stages, and shift the subsidy and incentive policies from a "blood transfusion" type to a "blood-making" type. Thirdly, improve the risk-sharing and service support system, expand the coverage of policy-based insurance, raise claim settlement standards, and link them with market prices, forming a risk-sharing mechanism involving finance, insurance, and herders. Consolidate grassroots management services at the county, township, and village levels, strengthen basic guarantees such as grassland observation, technology promotion, and animal epidemic prevention to solve practical problems in herders' production and operation.

4.4. Internal mechanism of the synergistic effect of the three aspects

The three dimensions mentioned above do not advance independently but form a tightly integrated synergistic system, whose underlying principles can be roughly summarized as follows:

The natural foundation is the material prerequisite for industrial drive. Without a stable ecological carrying capacity and sufficient forage supply, the industrial chain extension cannot obtain high-quality and stable raw material sources, and industrial upgrading would be impossible. Industrial drive is the key driving force for activating the whole system. Only when herders achieve significant benefits of "reduced livestock without reduced income" through the industrial chain value-added can they spontaneously adopt scientific breeding and participate in grassland protection, thus transforming the natural foundation from passive protection to active defense and providing a broad mass base and policy implementation environment for institutional guarantees. Institutional guarantees are the stability factor for the first two aspects. When the industry encounters market risks and uncertainties in the early stages of transformation, policy subsidies and insurance support provide herders with the security to "dare to explore." As the industry gradually matures, a complete regulatory and technical service system also prevents industrial development from crossing ecological red lines.

The three dimensions form a "positive flywheel", where the natural foundation supports industrial development, industrial benefits feed back into ecological protection, and institutional guarantees are

integrated throughout to reduce risks. This synergistic effect enables Yushu Prefecture to find a high-quality development path of continuous improvement in grassland ecology, enhancement of the quality and efficiency of animal husbandry, and a steady increase in herders' income under the rigid constraint of grass-livestock coordination.

5. Conclusion

With the effective implementation of the grass-livestock balance system, the grassland ecology in Yushu Prefecture will continue to improve, and ecological animal husbandry will resolve the contradiction between "livestock reduction and income increase." This study shows that the ecological animal husbandry in Yushu Prefecture faces many challenges, which stem from structural problems caused by the synergy failure of the three subsystems of the "nature-industry-system." To solve this problem, it is not enough to rely solely on surpassing a single aspect or simply juxtaposing countermeasures. Instead, it is necessary to first understand the essential connections between them, take solidifying the natural foundation as the premise, stimulate industrial value as the core, and support it with a complete institutional guarantee, forming a trinity development path. Under the collaborative operation of all aspects, Yushu Prefecture can find a win-win path that balances ecological protection and industrial development under the strict constraint of the grass-livestock balance.

Disclosure statement

The author declares no conflict of interest.

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