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Review

Grassland Ecosystem Service and Its Enlightenment on the Revitalization of Rural Ecological Animal Husbandry in the Rocky Desertification Area: a Literature Review

Shuzhen Song, Kangning Xiong*, Yongkuan Chi

School of Karst Science, State Engineering Technology Institute for Karst Desertification Control, Guizhou Normal University, Guiyang 550001, China

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Abstract

As an important part of the terrestrial ecosystem, the grassland ecosystem plays an important role in maintaining the balance of the ecosystem, and has irreplaceable social, economic and ecological functions for human well-being, in particular, it plays an important role in the process of karst rocky desertification control in typical ecological fragile areas. In recent years, more and more scholars have begun to pay attention to grassland ecosystem services, but there are relatively few systematic studies on grassland ecosystem services. Therefore, this study conducted comprehensive evaluation and qualitative analysis based on 209 relevant literature sources retrieved from databases such as CNKI (China National Knowledge Infrastructure) and Web of Science. Firstly, the literature was analyzed through annual distribution, research content, research area, research institutions and research topics. Secondly, the research progress and achievements were classified and summarized. Finally, the key scientific problems and future development directions were summarized for the existing research on grassland ecosystem services to improve grassland ecosystem services and promote rural industry revitalization in the karst area.

Keywords: grassland ecosystem services, ecological animal husbandry, rural revitalization, rocky desertification, karst

Introduction

Ecosystem services are all environmental conditions and processes for natural ecosystem formation and maintaining human survival and development [1]. Ecosystem services, as a bridge connecting the natural environment and human society, are at the forefront of current research in geography and ecology [2-7]. The karst ecosystem is a unified whole formed by the continuous exchange of material, energy and information between biological and abiotic environments within the karst region, and the interaction of various elements within the system, due to its fragile basal environment,

*e-mail: xiongkn@gznu.edu.cn

slow forward succession, poor stability and weak resistance to interference [8], it presents significant vulnerability characteristics in the framework of structure-function-habitat [9], and it is one of the typical fragile ecosystems worldwide [10]. Under the interaction of natural factors and long-term unreasonable human activities, the karst ecosystem is severely damaged, the ecosystem service function is gradually degraded, and the problem of rocky desertification is prominent. At the same time, the karst area is the main distribution area of the relatively poor population in China [8], which is faced the dual pressure of ecological protection and social and economic development.

Grassland is the pioneer plant community ecosystem for ecological restoration [11-12]. Grassland ecosystem, as an important part of the terrestrial ecosystem, has irreplaceable social, economic and ecological functions for human well-being [13-17]. Therefore, the development of vegetation compound management and characteristic ecological derivative industry models based on local conditions in karst areas have been proposed and adopted [18-20]. Grassland ecosystem of rocky desertification control plays an important role in the process of rocky desertification control. In the past 20 years, the implementation of rocky desertification control project has achieved remarkable results, the rocky desertification control task began to shift towards the transformation of organic integration of rocky desertification control-ecological derivative industry development-ecological service function improvement-livelihood well-being at present [18, 21]. However, there are still prominent difficulties in consolidating the achievements of rocky desertification control and that the function of ecosystem services does not meet expectations [20], which seriously hindered the progress of ecological civilization construction and rural revitalization strategy in the karst area. The ecological derived industry of grassland animal husbandry, which formed by the mode of grassland ecological animal husbandry of rocky desertification control with the improvement of ecosystem services as the core, is one of the contents of the development mode of scientific and technological poverty alleviation of the rocky desertification comprehensive control project [22], relying on high-quality resource endowment and ecological environment conditions to circulate the material flow and energy flow in the grassland ecosystem, it reduces the excessive development and exploitation and utilization of fragile ecosystems, improves the overall situation of the regional ecological environment, and optimizes the ecosystem structure and service function.

It has been shown that grassland played an important role in the process of rocky desertification control, which can not only achieve greater net primary productivity, water and soil retention and improve ecological benefits in a short time [23], but also improve the production and living standards of people and promote social and economic development in the karst area [13, 24]. However, the current research of grassland ecosystem services in the karst rocky desertification control area generally has prominent problems such as insufficient interpretation of internal driving mechanism, insufficient trade-off and synergy research between various functions, and unclear connection mechanism between service and well-being. So how to improve ecosystem services to consolidate the achievements of rocky desertification and improve human well-being under the new situation is an urgent task. Therefore, in order to provide a scientific reference for the revitalization of ecological industries, ensure the effective connection of rocky desertification control and rural revitalization strategies, promote the construction of ecological civilization and realize the healthy and sustainable development of society and economy in the karst areas, this paper comprehensively analyzed the existing grassland ecosystem service research, classified the literature through annual distribution, research content, research area, research institution and research theme, summarized the progress and achievements of grassland ecosystem service research, and discussed the enlightenment of grassland ecosystem service research on the revitalization of rural ecological animal husbandry in the karst rocky desertification area.

Materials and Methods

This review was conducted as systematic evaluation and qualitative analysis of the literature based on the literature search (Fig. 1). To obtain relevant literature, we used the literature database of CNKI and Web of Science, taking "full text/title/topic/key words" as the search term, using "ecosystem" and "ecosystem services" as the first search words, the second search will be carried out using "grassland ecosystem" and "grassland ecosystem services" as the search words. The deadline was July 30, 2021. After manual screening, a total of 209 (101 Chinese literature, 108 English literature) were retrieved from grassland ecosystem services, including 187 journals, 2 doctoral dissertations, 12 master theses, 5 conference papers, 2 patents and 1 monograph.

Research Progress in Grassland Ecosystem Services

Annual Distribution of the Literature

The study of grassland ecosystem services showed fluctuating growth, roughly divided into two stages (Fig. 2). The first stage was from 2003 to 2014, during which the total annual literature number was higher in 2010, 2007 and 2013, with 21, 15, and 15 articles respectively; the second stage is from 2015 to 2021, showing an ups and downs trend with large fluctuations, the total annual literature volume during the period was higher in 2019, 2016 and 2020, with 21, 15, and 19 articles

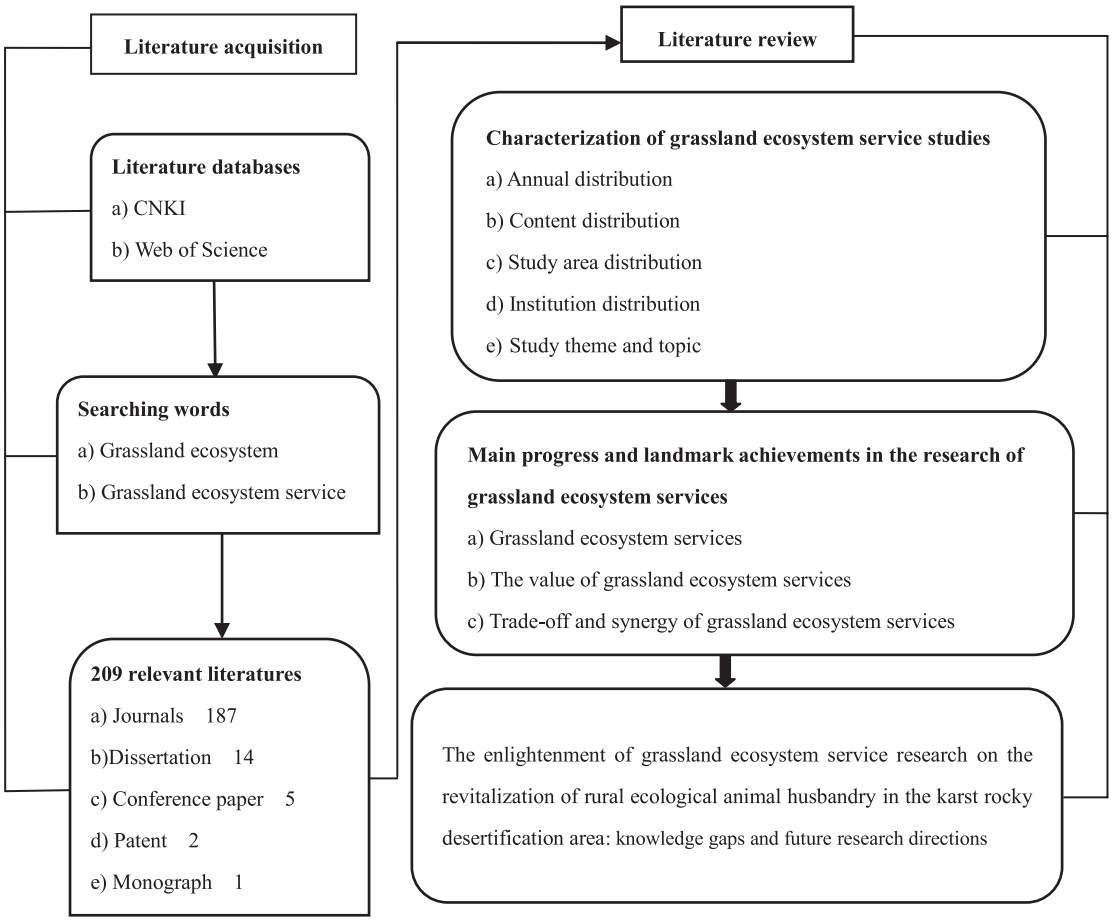

Fig. 1. Flowchart of literature acquisition and literature review.

respectively. In addition, the annual trend of publication literature number of Chinese literatures and English literatures was roughly the same. Before 2016, the number of Chinese literatures was generally higher than the number of English literatures. After 2016, the number of English sources was significantly higher than the number of Chinese sources.

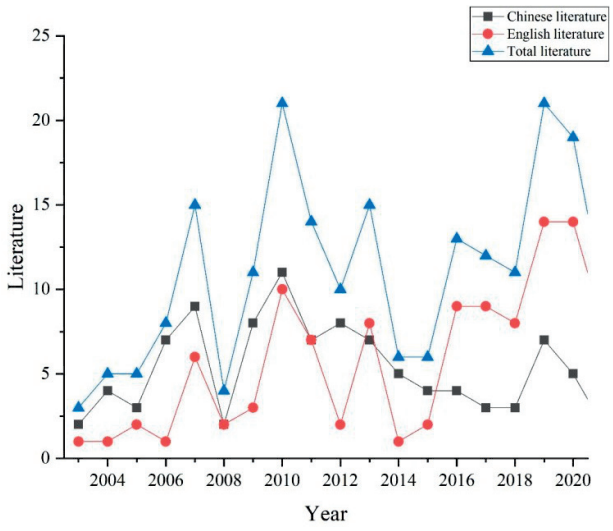

Fig. 2. Annual distribution of literature in grassland ecosystem service research.

Content Distribution of the Literature

According to the reviewed literature research content, the relevant research of grassland ecosystem services were divided into ecosystem services and function, ecosystem service value, trade-off and synergy, technology and methods, and other five categories, accounting for 34.72%, 35.75%, 7.77%, 10.36% and 11.40% respectively (Fig. 3). The content distribution of literature indicated that the study of grassland ecosystem services so far has focused on ecosystem service and function and ecosystem service value evaluations, while trade-off and synergy were less involved.

Study Area Distribution of the Literature

Among the 130 English research papers of grassland ecosystem services reviewed, the study area was mainly concentrated in Asia, Europe, and North America (Fig. 4). In particular, the study area of literature in China was most, accounting for 53.47%, which was a hot study area, France (16) ranked second, accounting

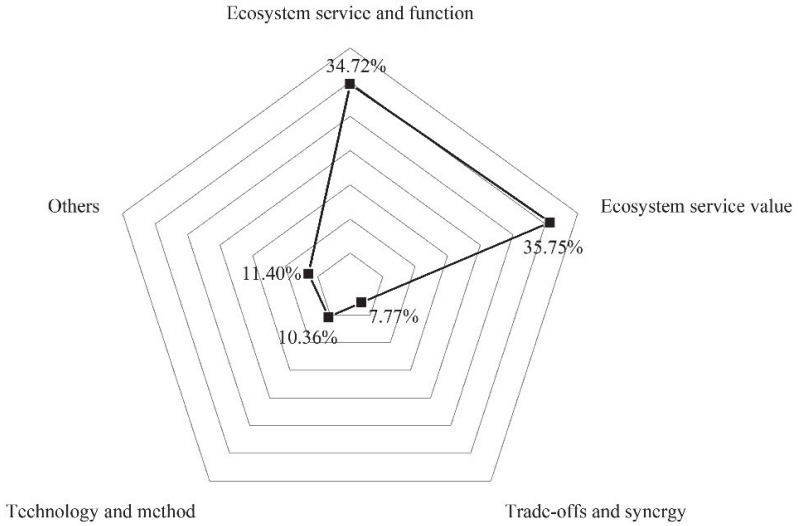

Fig. 3. Content distribution of literature in grassland ecosystem service research.

for 15.84%, followed by the United States, the United Kingdom and Germany, the number of literature was more than 3. The study area of Chinese literature was mainly concentrated in the northwest region and the Qinghai-Tibet Plateau (Fig. 5), accounting for 89.11%, with the largest number in Inner Mongolia (33), accounting for 32.67%, followed by Qinghai and Tibet, the number of literature was more than 15. The number of literature in other 13 provinces (cities), such as Guizhou, Sichuan, Yunnan, Gansu, Xinjiang and other provinces (cities), which was less than 10. From a global perspective, the study objects of grassland ecosystem services were mostly concentrated in the alpine grasslands of the Qinghai-Tibet Plateau, the steppes in Eursia and the tallgrass prairies in North America. From the perspective of China, it was mostly concentrated in alpine grasslands, arid grasslands, semi-arid grasslands, arid and semi-arid grasslands.

Institution Distribution of the Literature

Institution distribution of the literature in grassland ecosystem services was illustrated in Fig. 6. Due to space limitations, only institutions with three or more research articles were listed. From the reviewed literature, it was found that most of the contributing institutions were located in Asia (Geographic Sciences

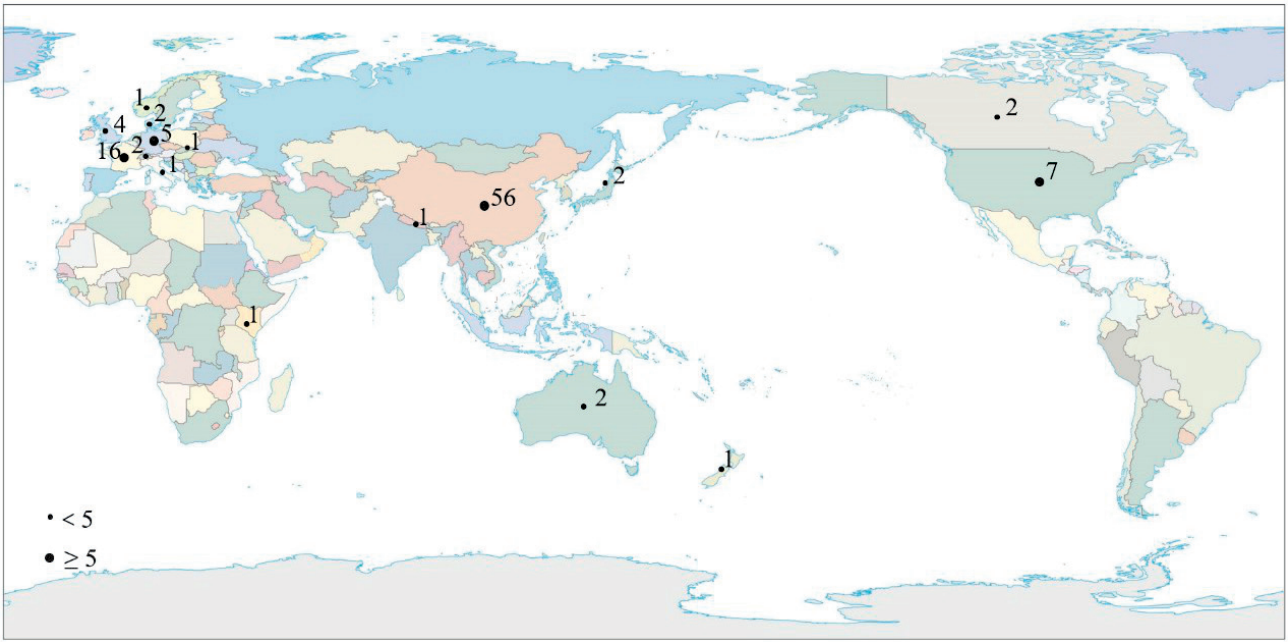

Fig. 4. Study area of English literature in grassland ecosystem services (source of world map: http://bzdt.ch.mnr.gov.cn/).

Fig. 5. Study area of Chinese literature in grassland ecosystem services (source of China map: http://bzdt.ch.mnr.gov.cn/).

and Natural Resources of Chinese Academy of Sciences, Lanzhou University, Inner Mongolia Agricultural University, Beijing Normal University, General Station of the Grassland of Qinghai Province, Ecological Environment Center, Chinese Academy of Sciences, Ningxia University, Guizhou Normal University,

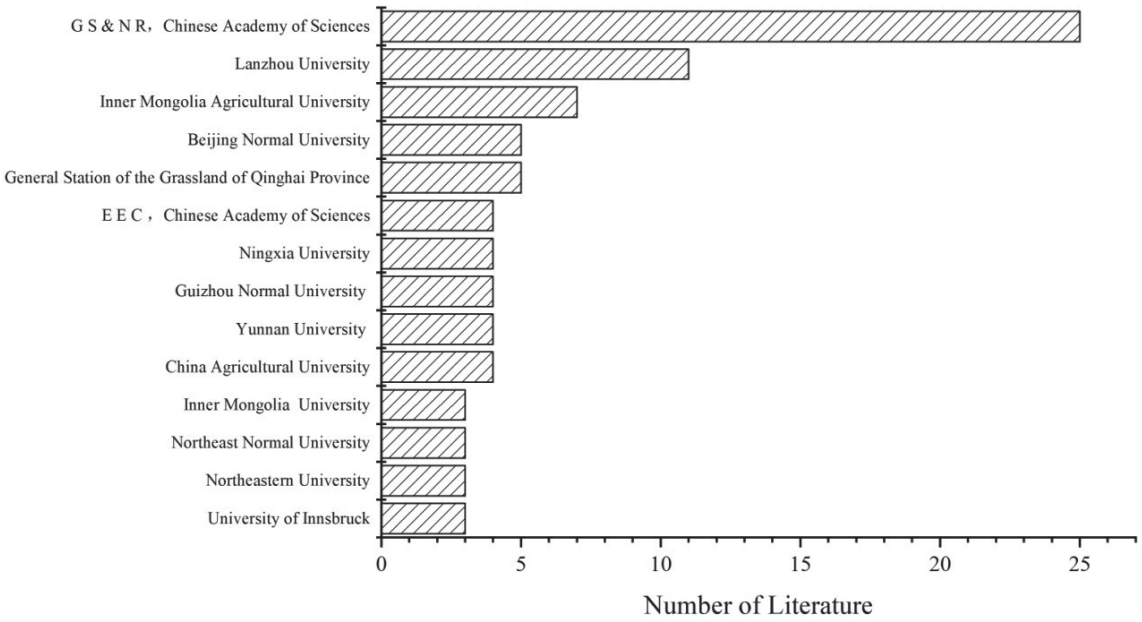

Fig. 6. Institution distribution of the literature in grassland ecosystem services.
Note: G S&N R represents Geographic Sciences & Natural Resources, E C C represents Ecological Environment Center

Fig. 7. Grassland ecosystem service: word cloud visualization.
Note: word cloud generated based on words in the titles, keywords and abstracts of the relevant study in grassland ecosystem service.

Yunnan University, China Agricultural University, Inner Mongolia University, Northeast Normal University and Northeastern University), followed by University of Innsbruck. It was not difficult to find that the institution distribution of the literature was closely related to the study area distribution of literature, because Asia was a hot study area, the institution distribution of the literature was mainly concentrated in Asia.

Study Theme and Topic of the Literature

To better present all the study theme and topic of the literature on grassland ecosystem services, we used the word cloud for word frequency analysis. According to the word cloud in Fig. 7, "grassland", "ecosystem", "service", "value", "function" and "evaluation" were the most commonly used words in the research of grassland ecosystem services. In addition, hot study area also appeared more frequently (such as China, Inner Mongolia, Tibet, Qinghai, etc.).

Main Progress and Landmark Achievements

Grassland Ecosystem Service

Identifying the definition of grassland ecosystem services is the basis for conducting related research on grassland ecosystem services. As the largest ecosystem on land, grassland is a complex economic, social and ecological system, and it is an important part of the ecosystem. The concept of grassland ecosystem service stems from ecosystem service. The concept of ecosystem services sprouted in the 1960s [14]. In 1970, the term ecosystem was first used in the SCEP (Study of Critical Environment Problems) report [25]. Westman described ecosystems as "natural services" [26]. Ecosystem service was formally proposed as a professional term in 1982 [27]. The publication of groundbreaking research results of Daily [1] and Costanza [28] in 1997 has attracted attention to ecosystem services from numerous scholars and decision makers around the world. In 2001, the MA (Millennium Ecosystem Assessment) project, organized by the United Nations, redefined ecosystem services and believed that ecosystem services refer to the various benefits that humans obtain from ecosystems [29]. Zhao et al. defined grassland ecosystem services as the natural environmental conditions and utility that humans rely on formed and maintained by the grassland ecosystem and its ecological processes [13]. At present, the definition of grassland ecosystem service is not unified, and most scholars use this concept widely.

The classification of grassland ecosystem service provides the possibility for research on grassland ecosystem service. The classification of grassland ecosystem service can be divided into two aspects. One was to classify them according to their functions. At present, most scholars use the classification schemes of Constanza and MA for the classification of grassland ecosystem service. Zhao et al. summarized the functions of grassland ecosystems as providing, regulating, cultural and supporting [13]. Qiao et al. summarized the grassland ecosystem functions into six ecological service functions: soil and water conservation, water resource conservation, environmental purification, nutrient circulation, biodiversity and recreation [30]. Sanderson et al. proposed the concept of ecosystem multifunctionality and suggested that grassland ecosystems in addition to providing functions of primary productivity have other functions related to environmental benefits and human-centric economic benefits [31]. Liu et al. divided the grassland ecosystem service functions into ecological functions, production functions and living functions [32]. The second was to classify them according to the value, Wang et al. believed that grassland ecosystem functions can be divided into two categories, one was which can directly sell commercialization functions (food, medicinal materials, animal husbandry, industrial raw materials, etc.), and the second category was difficult to commercialization functions (soil conservation, climate

regulation and waste assimilation, etc.) [33]. Yang et al. divided the grassland ecosystem service function from four aspects of direct value, indirect value, selection value and existence value [34].

The formation and change mechanism of grassland ecosystem services. Ecosystem is the material basis for the formation of ecosystem services and functions [35], and the maintenance and provision of its functions cannot be separated from the ecosystem structure, ecosystem process and habitat [36]. Biodiversity plays an important role in ecosystem service formation and maintenance through its own attributes and functions, klaus et al. argued that biodiversity ecosystem service experiments can reveal the basic formation mechanisms of ecosystem service function, but low levels of biodiversity can affect the maximum performance of permanent grassland ecosystem function [37]. Wang et al. [33] and Cheng et al. [38] analyzed the formation and change mechanisms of grassland ecosystem services from the perspectives of plant community diversity and soil biodiversity. Changes in habitat will affect the composition, structure and function of ecosystem services [39], while climate change [40-41], land use changes [17], ecological governance projects [42] and other factors have a particularly obvious impact on it. In recent years, with the intensification of human activities, the performance of ecosystem services has been significantly affected, so people have gradually realized that it is necessary to start with the formation and change mechanisms of grassland ecosystem services to carry out corresponding research, so as to better serve the management of grassland ecosystem services.

The Value of Grassland Ecosystem Service

The evaluation index system of grassland ecosystem service value was constructed. Determining the grassland ecosystem service functions and their division can better evaluate the value of grassland ecosystem services. Based on the mechanism analysis of grassland ecosystem service function, Zhao et al. constructed 13 functional evaluation index system of grassland ecosystem service that was composed of animal husbandry products, plant resource products, climate regulation, soil carbon accumulation, water regulation, erosion control, air quality regulation, waste degradation, nutrient circulation, ethnic and cultural diversity, leisure tourism, soil consolidation and fertility improvement, and habitat provision [13]. Yin et al. established an eight indicator system for the service value of grassland ecosystems in China, including water and soil conservation, water conservation, carbon fixation and oxygen release, maintenance of biodiversity, air purification, ecotourism, waste treatment and nutrient recycling [43]. According to the MA evaluation framework, Fang et al. constructed 12 grassland ecosystem service value evaluation index systems in the Haihe River Basin of China, which are food, medicinal materials, tourism, nutrient maintenance, biodiversity protection, carbon fixation, oxygen release, water conservation, soil conservation, environmental purification, waste degradation, rest and entertainment [44].

Value evaluation methods of grassland ecosystem service. Value evaluation method is closely related to monetary price, and the accuracy of evaluation method can better reflect the overall scarcity of ecosystem services. At present, the main methods to evaluate the value of grassland ecosystem services are direct market method, alternative market method and simulated market value method. The direct market method mainly includes expense method, asset value method, market value method, human capital method, etc. The direct market method can directly estimate the value of grassland ecosystem services. The substitution market method mainly includes substitution cost method, opportunity cost method, recovery and protection cost method, shadow engineering method, etc. Substitution market method is mainly used to estimate the value of grassland ecosystem services that are difficult to calculate directly with market value. The simulation market method is also called conditional value simulation method, which mainly includes questionnaire survey method, priority evaluation method, willingness survey and evaluation method, Delphi method, bidding game method, fee-free selection method and comparative game method [45]. The simulated market value method is one of the widely used methods of evaluating grassland ecosystem service value, which is mainly conducted on the basis of unreal market behavior. Zhao et al. evaluated the service value of mountain shrubby-grassland ecosystem in Lhasa-river valley of China by using the market value method, substitution engineering method and shadow price method [46]. Chen et al. evaluated the indirect value evaluation of the grassland ecosystem service function in Liaohe River Reserve of China using the shadow engineering method, market value method and opportunity cost method [47]. Yuan et al. estimated the economic value of ecosystem service under the four typical degraded grassland recovery methods of Horqin Sandy Land of China by means of opportunity cost approach, shadow price method, market price replacement cost method, and carbon tax method [48].

Value evaluation of grassland ecosystem service. At present, the problem of grassland ecosystem service decline is widespread due to people's insufficient understanding of grassland ecosystem service value, it is particularly urgent to accurately assess the value of grassland ecosystem services, and the display of value assessment results can arouse people's attention to grassland ecosystems. Xie et al. [49-50], Liu et al. [32], and Lou et al. [51] evaluated the value of the Chinese grassland ecosystem service, the natural grassland ecosystem on the Qinghai-Tibet Plateau, the alpine grassland ecosystem in northern Tibet, and the XilingGol League grassland ecosystem, respectively.

Although many scholars have evaluated the functional value of grassland ecosystem service, the results of the evaluation value of grassland ecosystem service in the same time and the same area are inconsistent due to different indicators and evaluation methods. For example, Zhao et al. estimated the total value of 6 type services (erosion control, precipitation interception, soil carbon accumulation, waste degradation, nutrient recycling, and habitat provision) for grassland ecosystem in China was 8803.01×10^8 yuan by using material quality evaluation method [13], but Jiang et al. estimated that the total value (organic matter production, maintenance of CO_2 and O_2 balance, nutrient circulation, purification of environmental pollution, soil erosion control and water conservation) of grassland ecosystem services in China reached 17050.25×10^8 yuan by using remote sensing technology [52]. Min et al. used energy theory and methods to estimate the value of grassland ecosystem service in Qinghai Province to be about 1689.12×10^8 yuan/year [53], while Zhao et al. assessed the total value of grassland ecosystem services in Qinghai province of China to be $2\ 935.63\times10^8$ yuan/year by integrating the multi-source, multi-scale and multi-process of the ecological environment data, and combining with large-scale field survey data in Qinghai province [46]. Chen et al. concluded that the value of grassland ecosystem service in Three-River Headwaters region of China in 2000 was 562.60×10^8 yuan by using a variety of methods based on the MA's ecosystem service classification system [54], however, Lai et al. evaluated the value of grassland ecosystem service in in Three-River Headwaters region of China in 2000 was 884.97×10^8 yuan by quantified and monetized physical value methods [55].

Trade-off and Synergy

Ecosystem services include nature (natural supply of ecosystem services) and social economy (demand for ecosystem services that humans obtain benefits from nature) [24]. The grassland ecosystem provides mankind with all kinds of products and services needed for production and life, but the various services provided do not exist independently, they are closely related, and the harmonious development of various services is of great significance to human well-being. Due to the diversity of human needs and choices and the complexity of grassland ecosystem service, there are complex interrelationships between various functions of grassland ecosystem services in their dynamic changes, that is, trade-offs and synergy between ecosystem services [56-59]. Normally, the ecosystem can self-regulate so that each service is in a balanced or stable state, when the external force received is lower than the threshold of the ecosystem's own regulation, the ecosystem can restore its own service through self-regulation, and people still can obtain products and services from the ecosystem; but when the external force exceeds the threshold of the ecosystem's self-regulation, due to the limited self-regulation ability of the ecosystem, the ecosystem is damaged or even collapsed, which will seriously affect the maximum service [60], especially with the increasing intensification of human activities, the ecosystem's supply services continue to rise, the regulation function of ecosystem gradually declines, the ecological balance is severely damaged, and even the production and life of human beings and sustainable social and economic development are seriously affected. Therefore, studying the trade-off and synergy of grassland ecosystem service is of great significance to the ecological protection of fragile ecological environment, the promotion of ecological construction and the realization of sustainable development among various regions.

Study method of trade-off and synergy. In order to avoid the uncertainty of the trade-off and synergy for grassland ecosystem services, take accurate measures of the services provided by the grassland ecosystem, better reveal the relationship between the grassland ecosystem services, so it need more and more research methods to explore the trade-offs and synergy relationship of grassland ecosystem service. The existing study methods of the trade-off and synergy for grassland ecosystem services can be roughly divided into statistical description method, spatial analysis method (spatial drawing method), model simulation method and scenario simulation analysis [61]. Rao et al. used the extreme value method to construct a trade-off utilization model of the grassland ecosystem services, and used biomass as the key variable of ecosystem service value to analyze the utilization of the grassland ecosystem services in Zhenglan Banner [62]. To evaluate the impact of grain for green plan on grassland ecosystem services, Wang et al. analyzed the trade-off relationship of three ecosystem service indicators of water production, soil conservation and net primary production of grassland ecosystems in the karst region of Southwest China from 1982 to 2015 by using three ecological models of InVEST, RUSLE and CASA [63]. Taking the grassland in Yanchi County of Ningxia in China as the research object, Zhong et al. analyzed the spatial relationship of trade-offs and synergy between the grassland ecosystem services at the township scale by using the InVEST model to accurately measure the three key grassland services of carbon storage, water conservation, and soil conservation since the grazing prohibition from 2000 to 2015 [64].

Enlightenment of Grassland Ecosystem Services to the Revitalization of Rural Ecological Animal Husbandry in the Karst Areas

Different from other grassland development regions in the world, the karst ecosystem in southern China has a fragile ecological environment, severe rocky desertification, and prominent conflicts between human and land, which were embodied in soil fragility, hydrological fragility, vegetation fragility, and human

environment fragility [8]. Therefore, the development of compound vegetation management and characteristic ecological derivative industries in the karst areas according to local conditions have been successively proposed and adopted [18-20]. The ecological derivative industry formed by the combination of planting grass and raising livestock and ecological restoration, that is, ecological animal husbandry. As a virtuous cycle development model of ecology and economy, relying on high-quality resource endowments and ecological environment conditions, the material flow and energy flow in the grassland ecosystem can be improved. Which reduce the over-exploitation and utilization of fragile ecosystems by humans, improves the overall situation of the regional ecological environment, optimize the ecosystem structure and service functions, and provide technical support and pattern boilerplate for the construction of ecological civilization and rural revitalization in ecologically fragile areas. In order to better promote the development of rural ecological animal husbandry industry and the improvement of ecosystem service functions, ensure the consolidation of rocky desertification control achievements and the implementation of the rural revitalization strategy, the following inspirations were put forward.

Fully Understanding the Formation, Process and Evolution Mechanism of Grassland Ecosystem Services is the Basis for the Revitalization of Rural Ecological Animal Husbandry

The grassland ecosystem provides products for the development of ecological animal husbandry and is the material basis for the development of ecological animal husbandry. However, studies on grassland ecosystems developing under karst ecosystems lack scientific explanations for their structure, service processes, and maintenance of service performance [65]. Ecosystem services are generated from ecosystem processes and functions. Usually, the formation of one ecosystem service requires the participation of multiple ecosystem functions, which leads that the process of system service formation adds difficulty because of asymmetry between ecosystem functions and ecosystem services [50]. Grassland ecosystem services are closely related to human well-being. The unclear formation, process and evolution mechanism of grassland ecosystem services make it impossible to effectively assess the quality of grassland ecosystems and the supply capacity of ecological products, hindering the healthy and sustainable development of ecological animal husbandry in the karst areas, affecting the production and life of the local people. Ecosystem structure, ecosystem processes and habitats are the material basis for the maintenance and provision of ecosystem services. Based on the cascade effect of structure-process-function-service-human well-being, we should fully understand the formation, process and evolution mechanism of grassland ecosystem services, providers of ecosystem service functions and their functional relationships to better build a bridge between grassland ecosystem and animal husbandry, maximize and sustainable use of resources, and provide a foundation for the revitalization of rural ecological animal husbandry.

Taking Into Account the Stability and Carrying Capacity of Grassland Ecosystems, Scientific Guidance and Rational Allocation of Grassland Ecosystem Services are Important Prerequisites for the Revitalization of Rural Ecological Animal Husbandry

The stability and integrity of the grassland ecosystem affect the carrying capacity of the grassland ecosystem, and the stability and carrying capacity of grassland ecosystem indicate the capacity size of the grassland ecosystem service. Most of the current grassland ecosystem research is carried out from a single perspective of ecosystem stability (or ecosystem carrying capacity), and the problem of not comprehensively considering the stability and carrying capacity of grassland ecosystems is common. After years of development of a series of projects for rocky desertification control, the ecological environment of rocky desertification areas has been better improved, but the goal of rocky desertification control is not only the increase of vegetation coverage, but also the restoration of vegetation quality, structure and function. Moreover, we should start from the succession law and internal mechanism of natural ecosystems, focus on improving the self-healing ability of the ecosystem, improving the material products, service functions and ecological processes of the ecosystem, restoring the integrity of the ecosystem, enhancing the stability of the ecosystem, and improving the carrying capacity of the ecosystem while enhancing the versatility of the grassland ecosystem. In recent years, under the influence of natural and human factors, the grassland in the karst areas has been seriously degraded, the structure of the grassland ecosystem has been damaged, the environmental capacity has become smaller, the carrying capacity of the grassland has been reduced, the anti-interference ability has weakened, the stability has deteriorated, and service functions has declined [65], which not only brings huge pressure on the ecological environment, but also has a serious impact on human health, living environment, and quality of life. As an ecological derivative product of rocky desertification control, ecological animal husbandry is an industry in which the ecosystem provides materials and service products for human beings without compromising the stability and integrity of the ecosystem. It promotes the quality of grassland ecosystems and the supply of ecological products, and plays an important role in the overall improvement of capacity. Therefore, managers need to comprehensively consider the stability and carrying capacity of grassland ecosystems, adjust or utilize the relationship between ecosystem services

and improve the resilience and carrying capacity of grassland ecosystems through scientific guidance and rational allocation of resources in grassland ecosystems to realize the maximum utility of ecosystem services, provide a sustainable and healthy development environment for the revitalization of ecological animal husbandry, and comprehensively improve human well-being.

Clarifying and Quantifying the Relationship between Supply and Demand, Trade-offs and Synergies of Grassland Ecosystem Services is an Important Way to Revitalize Rural Ecological Animal Husbandry

Ecosystem services include two aspects: nature (natural supply of ecosystem services) and socio-economic (ecosystem services demand for human beings to benefit from nature), furthermore, the services and functions embodied by ecosystems at different scales are focused, and different groups have different needs for ecosystem services [24], and the trade-offs and synergies has appeared based on different needs [58]. Due to its own geological background factors, and the temporal and spatial heterogeneity of ecosystem service products, the balance of supply and demand, and the trade-off and synergistic relationship of grassland ecosystem in the karst rocky desertification control area are not clear in time, and the contradiction between man and land is acute, which seriously restricts the revitalization of rural ecological animal husbandry. The essence of trade-off and synergy in grassland ecosystem services is the trade-off and synergy between the supply and demand of different groups between the society and the ecosystem, and the maximization of benefits can be achieved by adjusting or utilizing the objective balance and synergy between grassland ecosystem services. Therefore, on the basis of clarifying the grassland ecosystem service mechanism, combined with the process of rocky desertification control and the needs of ecological animal husbandry development [66], described the information flow of grassland ecosystem services, clarified and quantified the relationship between supply and demand, trade-offs and synergies of grassland ecosystem services, balanced and coordinated the needs of various stakeholders at different temporal and spatial scales to reveal the trade-off and synergy mechanism of grassland ecosystems, improve the multi-temporal and multi-scale product supply and service supply capabilities of grassland ecosystems, promote the coordination of human-land systems, and realize the harmonious coexistence of development and protection [67-68]. That is not only a concrete manifestation of the coordinated development of ecology and industry in the process of rocky desertification control, but also an important way to revitalize rural ecological animal husbandry.

Improving the Decision Support Ability of Grassland Ecosystem Services in Resource Management Practice is an Important Guarantee for the Revitalization of Rural Ecological Animal Husbandry

The accurate description of ecosystem service value and ecological assets can deepen the understanding of ecosystem services by resource managers and users, and it is an important bridge for the transition of ecosystem service theory from academic discussion to decision-making practice [32]. However, the geological backgrounds and temporal and spatial heterogeneity of grassland ecosystem development in the karst area is different from other regions of world, and the inconsistency of accounting index system in grassland ecosystem service value and ecological asset have resulted in the evaluation and accounting results still remain uncertain, so policymakers have not really used it to guide actual resource management assessment practices. Moreover, the increasing contradiction between grass and livestock in the karst areas has changed the composition, structure and function of grassland ecosystem, which severely weakened ecosystem services and delayed the recovery of ecosystem services, it also leads that the development of ecological animal husbandry is facing unsustainable problems. Coordinating and optimizing the production, living (improvement of the ecological human settlement environment) and ecological functions of the grassland ecosystem, accurately describing the service value and ecological assets of the grassland ecosystem, improving the supply capacity of ecosystem products, revitalizing the stock resources, and then using the stock to drive growth to increase the value of grassland resources while fully releasing its ecological, economic and social value, alleviate the contradiction between grass and livestock, promote ecological security and ecological civilization construction in karst areas, and realize the sustainable development of ecological animal husbandry, which is an important guarantee for the revitalization of rural ecological animal husbandry.

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Conflict of Interest

The authors declare no conflict of interest.

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