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Abstract: The relevance of the study lies in the critical role that pastoralism plays in sustaining human populations and providing environmental services, as well as its contribution to subsistence farming in some of the world's poorest regions. The purpose of the article is a complete and in-depth review of pasture farming as a land use system in Kazakhstan. The article presents the main methods of rational use of pastures, developed for use in the climate and economy of Kazakhstan. The experience of other countries confirms the importance of agrotechnical measures and the introduction of innovative means in the long term. Marketing tools will change the image of the agricultural industry in the eyes of many people and potential specialists, and government assistance with legal support and administrative accounting will help attract investment.

Keywords: agriculture; pastoralism; land; economy; grazing

1. Introduction

Animal husbandry represents one of the fundamental models of human successful existence that dates back more than 100 centuries before global warming ended the Pleistocene era (from about 2.6 million to 11700 years ago). Except for dogs, the earliest domesticated animals were horses, as well as ruminants and cattle. According to archaeological evidence, the domestication of animals in Kazakhstan dates back to the 4th millennium BCE. Excavations at the Botai culture site in northern Kazakhstan have uncovered evidence of early horse domestication, with horse bones showing signs of bit wear indicating the use of bridles and possibly riding (Figure 1)¹. But the domestication of dogs in Kazakhstan dates back to at least 8000 years ago. One of the earliest known dog breeds, the Alabai or Central Asian Shepherd Dog, has been found in ancient burial sites in Kazakhstan dating back to the Bronze Age (from 3300 BC to 1200 BC)².

Livestock provides meat and milk, which are staple foods for many groups of the population. In addition, these animals have not only food productivity but also practical value – wool productivity, transportation of goods, and riding transport (camels). With sufficient and excessive production and the resumption of livestock, it

is possible to improve the situation in the economy of the republic due to exports. As incomes rise, the demand for meat and dairy products from livestock increases, leading to strong economic incentives to intensify pasture livestock production. It is very important to use pastures rationally in order to maximize the effect of feeding livestock and minimize land degradation. Studies prove that only with the careful use of pasture land, is it possible to achieve maximum productivity, coupled with the preservation of biodiversity. Moreover, maintaining good site conditions is more cost-effective than dealing with the consequences of destruction^{2,3}.



Fig. 1: Map of domestication of horses in Kazakhstan

In connection with the current policy of import substitution, the transition of the republic's economy to a “green” one, which is reflected in many legislative documents, this work has scientific novelty, indicating the vector of the industry's profile development for the coming years. Pastures also tend to occupy the geographic periphery of modern states, alienating pastoralists from urban centers. Modern threats to livestock occurred in the context of irrational use of pasture lands, ineffective methods of administrative and economic accounting, as well as against the background of a general vector of anthropogenic influence^{(4),(5)}. For example, for the Sudano-Sahel region, the grazing livestock value and production quantity chain include millions of herders, farmers, and entrepreneurs. However, in unplanned situations such as war, natural disasters, plant, animal, or soil contamination by a virus, or simply poor management, the consequences spread throughout the entire region, threatening food security and economic stability. In addition, given the significant population growth, the volume of production may not be enough in the coming decades. The future of pastoralism as a production model is contested – the effectiveness of pastoralism in drylands and its social and environmental impact is the subject of ongoing and bitter controversy among policymakers and experts⁽⁶⁾.

The accounting policy is also an exceptional issue in a market economy; its assessment is important for calculating the marginality of the industry. Accounting, with the results of its activities, is intended to provide all interested parties with complete and reliable information on the financial results of organizational performance. In addition to internal users – the owners of the company, affiliates, in this case, are also external users – partners, creditors, and investors. High-quality accounting will allow both seeing the current state and tracking the dynamics of development. In addition, due to the continuous logging of all business transactions, it is possible to obtain a variety of reports for further regulation of finance in the organization of cattle breeding as a branch of activity. The agricultural sector in the world is so important and so different from other

industries that it has its own accounting standard – International Accounting Standard No. 41 “Agriculture”⁽⁷⁾. Legal support of the state is also important to ensure security in the event of disputable situations. This work is aimed at generalizing the experience of other countries and the current situation in the studied area to form practical recommendations for development prospects⁽⁸⁾.

The study's relevance lies in its potential to offer solutions to the challenges faced by societies in Central Asia and contribute to sustainable pastoralism practices globally. The purpose of the article is a complete and in-depth review of pasture farming as a land use system in Kazakhstan. The problem addressed in the study is the impact of agricultural expansion, industrial development, and extensive cattle breeding on the practice of livestock raising, particularly on pastoralism in Central Asia. The study aims to address the mismanagement of pastures, degradation, and the need for rehabilitation of degraded lands by developing recommendations for the Republic of Kazakhstan.

2. Materials and Methods

The work is based on the method of in-depth analysis of an extensive list of literature, including both authoritative scientific articles over the past 10 years, and legal literature. In the course of the work, various points of view of researchers were studied, who actualize aspects of the problem under consideration in scientific works. To form a complete theoretical picture, it was necessary to refer to the experience of developed countries, to the data of advanced agricultural areas, as well as to the most modern publications. Processing of statistical data included the rate of population growth in the Republic of Kazakhstan, the use of the grazing area, and the average daily gain in the live weight of young animals. The study of scientific literature and the summing up of one's own knowledge in this area made it possible to generalize the accumulated experience and form conclusions and practical recommendations applicable to various aspects of pasture farming in Kazakhstan. The article presents the main elements of the rational use of pastures, developed for use in the climate and economy of Kazakhstan. The rangeland management plan and its practical application in productive livestock breeding are based on the following factors: a geobotanical study of pastures, livestock volume as a load on land, pasture yield, feedstock, carrying capacity, calculation of the optimal herd for pasture, assessment of the level of irrigation and other elements of effective pastures use.

The project developers use innovative digital technologies and methods that contribute to more efficient pasture management. Cartographic material on pasture resources of the republic includes the following: forage resources, water regime of pastures, and zoning of

cattle breeds. Expanding the issue of geobotanical studies, it is noted that they are usually carried out by ground route studies at certain seasonal intervals. Land survey work is carried out by qualified geobotanists or authorized organizations within the existing or planned land use. As to fodder reserves, the calculation of the fodder reserves of a specific area of pastures is carried out by multiplying the average annual yield by the area of pastures. Grazing load is calculated by dividing the yield of green forage in the corresponding period (kg/ha) by the product of the amount of pasture green forage per head per day (kg) and the duration of pasture use (days).

The definition of pastures of the initial degree of degradation includes those lands where plant species of the main layers of biocenoses, as well as subdominants, have still retained their ability to reproduce. For them, the main scheme of pasture rotation for preserving and improving the quality of pasture is a scheme with alternating plots for a period of four years and three seasons. Innovative methods implied the following: the main issues and solutions for digital management of pasture lands were prepared by the Kazakhstan Research Institute of Livestock and Forage Production in cooperation with the Institute of Geography and Water Security on the topics of the forage potential of pastures; irrigation of pastures, pressure on grazing land; breed segregation of livestock, organization of reserve pastures. Reduced-scale interactive maps allow viewing data of interest at the level of the region, district, and republic⁷⁾. For the first time in Kazakhstan, a specialized digital cartographic material was created and is functioning in a test mode according to the above-described parameters, which are the most significant for the pasture livestock industry.

3. Results and Discussion

At the present stage of development, the problem of attracting investment in the real sector of the economy is central. Attracting investments from other countries is problematic due to the current state policy towards “import substitution” and strengthening the role of the producer of each country, the business of the republic as a whole⁹⁾. In the case of Kazakhstan, the policy was introduced in 2014 as a response to the economic crisis caused by falling oil prices and Western sanctions against Russia. The government aimed to reduce the country's reliance on imports and diversify the economy by developing its own industries. As part of this policy, the government provided various forms of support to local producers, such as tax breaks, subsidies, and protectionist measures. These measures were intended to encourage the development of new industries and the expansion of existing ones⁶⁾. In particular, the government targeted industries such as agriculture, manufacturing, and construction, which were seen as having the potential for growth and job creation.

The policy of import substitution has had mixed results in Kazakhstan. On the one hand, the government's support for agriculture has helped to increase domestic food production and reduce reliance on imported food products. On the other hand, some analysts have argued that the policy has been too focused on protecting existing industries rather than promoting new ones. Others have raised concerns about the quality and competitiveness of domestic products, which may not meet international standards or may be more expensive than imported goods.

But, returning to international activities and cooperation, obtaining information about the economic results of the company's activities in the form of compliance with international standards will increase the company's prestige in the eyes of investors from other countries and can become one of the significant aspects of making a positive decision. The agricultural sector is now rapidly developing for many reasons - ensuring food security for the growing population of countries, a course towards import substitution, the development of production technologies, the state's interest in improving quality indicators (high milk yield, reducing the cost of fattening beef cattle, increasing the efficiency of fields) relative to other countries¹⁰⁾. Moreover, an important aspect of the economy is the formation and operation of international agricultural holdings or attracting investors from other countries to cooperate in the field of agriculture. For successful cooperation in this format, it is necessary not only to introduce technologies and knowledge of other countries but also aspects of documentation, in particular, accounting.

Kazakhstan cooperates with various countries within the agricultural sector, including Russia, China, Turkey, Uzbekistan, and the European Union (EU) member states. Kazakhstan also has a strategic partnership with China in agriculture, and the two countries have signed a number of agreements to boost cooperation in this sector. Kazakhstan has also been actively developing partnerships with Turkey in agriculture, particularly in the production of fruits and vegetables. Finally, the European Union is also an important partner for Kazakhstan in the agricultural sector, with the two sides cooperating on issues such as food safety, veterinary and phytosanitary standards, and trade in organic products.

Although agriculture is an important part of the global economy, agricultural accounting still has many drawbacks. The adoption of International Accounting Standard No. 41 “Agriculture”⁷⁾ represented an attempt to improve this situation and increase the comparability of the financial statements of the agrarian sector entities. Despite the controversy, International Accounting Standard No. 41 Agriculture⁷⁾ is the first step in the gradual transition to fair value measurement in the agricultural sector. Skepticism and controversial views may be associated with general flaws in the law due to the relative novelty of the problem of accounting for

biological assets and the ambiguity of the views of different economic schools on the path of practical implementation of International Accounting Standard No. 41 “Agriculture”⁶⁾. In general, accounting rules in Kazakhstan are in line with European directives and in many respects converge with International Accounting Standard No. 41 “Agriculture”⁷⁾. However, the provisions of International Accounting Standard No. 41 “Agriculture”⁷⁾ are not directly reflected in local regulations. It is expected that with an increase in agricultural land transactions and growth in the percentage of investments from other countries in livestock farms, recognition and valuation of biological assets in accordance with International Accounting Standard No. 41 “Agriculture”⁷⁾ will become a necessity. The Republic of Kazakhstan has a significant area of rangelands (approximately 186.4 million hectares), but the lands of this status are in a state of abandonment or degradation due to improper use. Unfortunately, for a number of reasons, there is no sure vector for positive changes.

In those areas where the main productive livestock is raised, pastures are exploited “as before,” without applying theoretical knowledge and scientifically grounded standards: rotation, and utilization factors, which leads to land degradation. The soil and vegetation cover are preserved in their original and renewable form only on pasture lands that are not watered and are not exploited. The conversion of pasture to arable land has

caused one of the most significant environmental impacts of land degradation on Earth. In the Kazakh steppe, for example, 25 million hectares of pasture were converted to arable land in just seven years, and the degradation process is largely irreversible. The unsystematic use of pasture resources concentrated near settlements, and the lack of systematic work to increase their productivity is a serious brake on the development of the livestock industry¹¹⁾. Therefore, there is a need to introduce the so-called pasture rotation, distant pasture farming, and surface improvement – rejuvenation – of pastures¹²⁾. In Scotland, ecology concerns in agriculture are likely to increase the demands and control of pastoralists to reduce grazing pressure on semi-natural vegetation in order to preserve or restore biodiversity on the land. Based on the outlined land use theses, it can be argued that such requirements can be met only through more efficient use of pastures on uplands with regular rotation¹³⁾.

The economic and social developments of the past 100 years have led to the gradual disintegration and reshaping of social units necessary for pastoralism in a wide area of open and seasonally changing pasture ecosystems. Large-scale economic and ecosystem-safe movement of livestock in the Eurasian climate was only possible with large herds. This scale of herds of animals became possible thanks to three “modes of production” (Table 1). Humans have formed grazing land and sustainable field ecosystems that have recently become a natural landscape.

Table 1. Features of three “modes of production”.

No.	Entitled	Features
1	Domestic Production	The domestic mode of production, also known as kin-ordered production, is prevalent among foragers and small-scale subsistence farmers, who have a more egalitarian social structure than those found in other modes of production. Although age and gender-based forms of inequality still exist, labor in the domestic mode of production is organized based on kinship relations.
2	Tributary Production	The tributary mode of production is observed in societies divided into hierarchical classes of rulers and subjects. The subjects, who are often farmers or herders, produce goods for themselves and their families, as well as provide a portion of their produce or labor to their rulers as tribute. This mode of production is commonly found in pre-capitalist, state-level societies in different regions such as Europe, Asia, Africa, and the Americas.
3	Capitalist Production	The most recent mode of production is capitalism, which only emerged during the seventeenth and eighteenth centuries with the North American and Western European industrial revolutions. Unlike the other two modes of production, capitalism is an economic system based on private property owned by the capitalist class. While workers in the domestic and tributary modes of production typically own the means of production such as the land they farm, in the capitalist mode of production, workers usually do not own the factories or businesses they work for. Instead, they sell their labor power to capitalists in order to make a living. Despite the difficulty many of us may have in imagining an alternative to capitalism, it has only been a part of human history for a relatively short period of time.

The history of pastures in Kazakhstan shows how, for the sustainable preservation of natural systems, social conditions must be created for the collective management of pasture animal husbandry. These conditions are currently threatened by the administrative and economic constraints faced by small private herd owners¹⁴. Maintaining herd mobility requires a certain level of labor and capital investment, operating within structured socio-economic and political institutions¹⁵. An obstacle to increasing livestock mobility is that most livestock owners have a population that is too small to justify their individual investment in the technology (mainly, freight transport for transportation of animals between pastures and the development of watering points) needed to move livestock long distances to grazing¹⁶. In Kazakhstan, many small livestock owners are forced to continue grazing and feeding their livestock mainly around settlements, which has a serious impact on the environment, causing gradual but sustained land degradation.

To comply with the correct four-year rotation for the full restoration of grazing land, a sufficient number of grazing areas is required away from settlements. This can be achieved through the development of new, previously unused territories. This requires public or external investment as motivation¹⁷. New trends are observed – in particular, the re-development of previously known, but abandoned areas of state farms is taking place, which is associated with movements to pastures and watering areas, which pasture herders first occupied after the collapse of state farms in the mid-1990s¹⁸. Until the current decade, there was also no comprehensive program to revive distant pasture farming; the state had not previously provided assistance in creating a certain pasture infrastructure, in providing such an important branch of agriculture as animal husbandry with highly qualified scientific and industrial personnel¹². The adopted Law of the Republic of Kazakhstan No. 160-I “On environmental protection”¹⁹ could not fully solve all environmental problems associated with the use of pasture land in the republic. The existing restrictions relate to the structures and procedures of the state environmental management of territories, and the effective participation of institutional and local communities. In this context, the government has already taken steps to broaden the legal, policy, and institutional framework to improve pasture management through the development of appropriate initiatives.

Compliance with public relations related to the rational use of pastures and improving the condition of pastures and their infrastructure, preventing the processes of pasture degradation is ensured by the Law of the Republic of Kazakhstan No. 47-VI ZRK “On pastures”²⁰. It reveals the competence of all affiliated organizations and also addresses issues of rights, obligations, and procedures for the provision and use of pastures. The Order of the Minister of Agriculture of the Republic of

Kazakhstan No. 7 “On approval of the Rules for the rational use of agricultural land and amendments and additions to some orders of the Minister of Agriculture of the Republic of Kazakhstan”²¹ is in force, determining the procedure for the use of agricultural land. The integration of modern technologies into pasture animal husbandry will allow remote monitoring of environmental parameters, assessment of feed resources, online video surveillance to prevent criminals from entering, and automatic data transmission to the central communication station²². Despite the fact that pasture cattle breeding is economically promising, at present, there is no unified approach to the formation of a system of technical support for the infrastructure of pasture and distant pasture cattle breeding, as well as technical solutions proposed for the equipment of the infrastructure. There is no definite sequence of technical knowledge and methodological principles in the selection and evaluation of means. In order to substantiate the need for the introduction of technical means, it is necessary to analyze the entire system of grazing and management of remote pastures, its structure, indicators, and methods of work.

The technical equipment necessary for equipping SMART (Specific-Measurable-Assignable-Realistic-Time-related)-pastures within remote grazing is carried out according to a modular principle; a mobile complex of technical equipment is formed. The biocomplex for intelligent pasture animal husbandry provides infrastructure for the formation of environmental conditions appropriate to livestock farming (in particular, the use of anti-gravity heat pipes to cool the soil and stimulate the growth of forage vegetation), control systems based on renewable energy sources, water supply, and is an effective tool for the development of desert and reclamation of semi-desert for intelligent livestock management²³. Among the available technological developments in the Republic of Kazakhstan, it is worth highlighting the chapter from the recommendations on the use of pastures. The resulting database, which collects the most important elements of pasture use, will allow livestock farmers to gain an overview of the situation and make the right decisions on managing their livestock⁸. Each user can get access to the array of data of interest to him in the context of his region, district, or rural community on this information resource on agreed terms of commercial use. The possibility of remote monitoring of vast territories according to several parameters important for animal husbandry will allow reducing risks and increasing the quality of activities²⁴. An important aspect of the use of agricultural land is their efficiency – the number of products produced per unit area per unit of time. The general trend of demographic growth poses increasingly more serious challenges to the industry³.

The production of livestock products for export and economic development is possible only if the population of the republic is fully provided with this food product.

The population of Kazakhstan over the past 10 years has increased by 13.6% according to the population census, which gives a significant increase in the burden on the agricultural sector²⁴). Continuing the issue of demographic growth and food security, it is necessary to say that this is also a significant problem for the world community. Some of the research priorities stem from the current political trend to decentralize pasture management from the national to the local level in order to make it more “participatory” and closer to people. Empirical evidence suggests, however, that currently mountain pastoral communities in Kyrgyzstan are far from homogeneous and are characterized by striking inequalities in wealth and power¹⁶). This leads to conflicts and clashes. In another area, despite its proven adaptive capacity and dynamism, the livestock industry in the Sudano Sahel is undergoing unprecedented changes. The availability of water and arable land, as critical resources for successful livestock raising, is threatened by a complex mix of global and regional stressors - climate change, population growth, urbanization, recent economic trends, changes in land administration, and the rampant proliferation of weapons²⁵⁻²⁷). Pastoral communities, receiving little support from their governments, are struggling to cope with these changes by using threats, armed confrontation, and damage to other people's herds and lands²). Livestock breeders in other African countries face similar problems.

The Global Alliance for Sustainability Initiative was launched by the European Union in 2012. This initiative aims to help build the sustainability of vulnerable populations. The plans include expanding communities and conflict resolution programs in pastoral areas, conducting research on private investment, and advocacy programs²⁸). Observation shows that the Chinese model is very different from the practice of Kyrgyzstan and is embedded in an authoritarian approach, which assumes similarities with the implementation of the development model at the stages of collectivization in the Union of Soviet Socialist Republics and the People's Republic of China when the models of these countries were implemented in conditions of autonomy and settled life. However, the current context is completely different, as the ecological degradation of pastures and the non-existent narrowing of the development gap between wealthy urban dwellers and peripheral poor pastoralists have been bridged through the implementation of current resettlement programs. In the pastoralist regions of China, the responsibility aspect is associated with a top-down approach without the due involvement of all stakeholders. In neighboring countries, pastoralists, as a rule, complain about the negligence of state authorities, the non-binding nature of regulations, and arbitrariness on the part of influential persons. Countries such as India and Pakistan are still reworking their colonial heritage and trying to adapt pasture legislation to meet pasture management and nature conservation requirements²⁹).

As with many of the world's most vulnerable populations, the measures needed to curb the spread of the COVID-19 pandemic have severely undermined the ability of Kenya's pastoralists to carry out their income-generating activities and, as a result, jeopardized their economic security. As a rule, selling livestock is their main source of income, and generally large markets provide the opportunity for herders to buy food³⁰). Unfortunately, restricting markets also makes pastoralists economically vulnerable during COVID-19³¹). Here, it is expedient to mention the importance of state support in maintaining the industry's economy. In the “era” of coronavirus restrictions (since 2019), online commerce and delivery capabilities have exploded. For the periphery of the Third World countries, this issue is far from being realized, but with the centralized management of the industry, there is a prospect for the development of technologies. In Australia, as in the Republic of Kazakhstan, pastoralism in semi-arid and arid regions is the predominant land use, occupying about 40% of its territory. The question now is how to restore Australia's vast arid pastures from their current, significantly degraded state, to truly sustainable agricultural land. Overgrazing was a significant cause of land degradation but accounted for less than half of the total destructive impact. Non-domesticated animals such as rabbits, wild goats, and kangaroos increase grazing pressures, resulting in constant competition for scarce resources at the expense of plant and animal biodiversity³²). Any controlled grazing system should give the most nutritious plants time to recover with a rotary grazing system that is ineffective with large numbers of wild grazing animals.

The government is eliminating dingoes and other large wild animals to reduce pressure on pastures and, therefore, Australia has the highest mammalian extinction rate in the world. Experts believe that a constant disinformation campaign is being specially carried out ‘on the top’ to legalize the shooting of dingoes, despite the fact that it directly contradicts the available scientific evidence that the destruction of parts of the natural ecosystem will lead to its complete degradation. To provide grazing livestock with the necessary feedstock, it is worth looking for other ways with a focus on the long-term prospect³³). It is impossible not to mention the significant impact of livestock on greenhouse gas emissions and climate change in general³⁴). For example, in the Qinghai-Tibet Plateau, there is a synergistic interaction between global warming and livestock grazing. Good grazing management can be an important tool in curbing warming-induced shrub growth, mitigating the negative effects of global warming on rangeland quality. The ‘warmer future’ will certainly require flexible and supportive pasture management practices in many rangeland areas^{35,36}). It is very important to analyze the aspect of whether pastoralism in itself can be considered a sustainable production system

that deserves political support, or whether the pastoral production system is fundamentally inadequate with today's challenges in the sense that it is detrimental to the world's scarce resources. The research findings disclosed in the works of scientists show a significant consensus in the opinion that pastoralism is seen as a sustainable system for the production of livestock and livestock products³⁷⁾⁻³⁹⁾.

However, a total of 18 studies from the general population indicate limiting factors of land use. One of the tools that can improve the state of the industry in the long term is marketing and public relations (PR). Land use problems and general issues of pastoralism in the republic can be taken under control and solved with the use of competent PR work since with its help it is possible to instill in society and investment funds the idea of the prestige and importance of the industry, the need for its development and available prospects. The role of marketing boils down to strategic competence that allows livestock breeders and other stakeholders to create value for target buyers, with whom they can develop economic and social relationships that benefit both parties^{35),40)}. Nowadays, it is more important than ever to create an image of a livestock breeder that is "selling" and not frightening for the layman. For many people, pastoralism is associated with semi-nomadic communities, sometimes portrayed as leading outdated lifestyles, warring and degrading the environment along with their herd as they move into new territory. In fact, things are different. The European Commission supports pastoralism as one of the most efficient and environmentally friendly ways to benefit from arid and semi-arid lands, which is also relevant for the Republic of Kazakhstan. However, with the deteriorating impacts of climate change, population growth, and competing land claims, preventing conflict and ensuring the mobility of pastoralists is more challenging than ever^{28),41),42)}.

One example of the effective use of PR and marketing toolkit in Kazakhstan by the grazing sector is the "Kazbeef" brand⁴³⁾. Kazbeef is a leading beef producer in Kazakhstan, which uses modern technologies to produce high-quality meat products. The company has developed a strong brand image through effective PR and marketing strategies, such as:

1. Social media presence. Kazbeef has an active presence on social media platforms, such as Instagram and Facebook, where it promotes its products and engages with customers;
2. Brand ambassadors. The company has appointed popular Kazakh athletes and celebrities as brand ambassadors to promote its products and increase brand awareness.
3. Partnership with restaurants. Kazbeef has partnered with several high-end restaurants in Kazakhstan to showcase its premium beef products and increase visibility among target customers;

4. Participation in industry events. The company regularly participates in industry events, such as food fairs and trade shows, to showcase its products and network with potential customers.

In Central Asia, pastoralists face challenges due to the geopolitical and economic conditions in the post-Soviet states. Policies, programs, and projects related to pastoralism in Central Asia mainly focus on the extent and causes of pasture degradation and the need for pasture decentralization and privatization. However, there is a lack of recent data and more in-depth field studies to model the many interacting causes and feedbacks of changes in soil, vegetation, climate, and animal populations, both livestock and wildlife, to understand the biophysical consequences of profound changes in nature. Land management over the past 20 years. The authors believe that more in-depth research is needed to understand the problems associated with pastoralism in Kazakhstan and to find sustainable solutions for pasture management.

4. Conclusions

Globally, pastoralism plays a critical role in sustaining huge human populations, providing significant environmental services, preserving ancient civilizations, and contributing significantly to subsistence farming in some of the world's poorest regions. However, in recent decades, the practice of livestock raising has been suppressed by agricultural expansion, industrial development, and extensive cattle breeding. Societies living in the mountainous regions of Central Asia face particular challenges as a result of the geopolitical and economic conditions of the post-Soviet states. The main issues that have been highlighted over the past two decades in policies, programs, and projects related to pastoralism in Central Asia are focused largely on two aspects regarding the scale and causes of pasture degradation, as well as the need for decentralization and privatization of pasture lands. Conclusions about the mismanagement of pastures, degradation, and the need to rehabilitate them often echo earlier published short-term research assumptions and biases, usually without offering fresh data.

There is a clear need for deeper fieldwork and subsequent modeling of the multiple interacting causes and reverse effects of changes in soil, vegetation, climate, and animal populations, both as livestock and in wildlife, to understand the biophysical implications of profound changes in land management over the past 20 years. The first developments and recommendations for the Republic of Kazakhstan have already been published; they need to be field checked with logging and statistics for several years, which will allow seeing the development trend. Rotation of rangelands will allow reducing or completely avoiding land degradation. Remote control and prompt response to changes in important parameters of the climate, safety, and health of

both animals and employees will make it possible to centralize process management, reduce human resource costs, and increase the amount of data for statistical and other analysis.

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