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SUSTAINABLE LAND MANAGEMENT IN CORN FARMLAND, SOUTHEAST KAZAKHSTAN: REPORT FROM KAZAKHSTAN AND CHINA BORDER

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Abstract. The agriculture in semi-arid lands of Kazakhstan on the example of the Kazakh-Chinese border has been transforming since the 2010s. This study examines corn farming practices and related state policies in Kazakhstan and makes policy recommendations for future sustainable land management (SLM) implementation. Through interviews with key informants and a review of policy documents, this paper identifies the following: 1) the study site has three farming issues depending on the geography; 2) farmers have positive agricultural practices for SLM adoption, such as crop rotation and manure usage; and 3) the agricultural enterprises established by the Agricultural Investment Policy have influenced the expansion of corn cultivation since the 2010s.

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These findings suggest it is possible to sustainably improve agricultural production in the study area, which is affected by infrastructure development between China and Kazakhstan, through the introduction of appropriate technology for each elevation and the development of sustainable agricultural land through cooperation with local companies.

Keywords**:** *Kazakhstan, Borderland, Semi-Arid land, Sustainable Land Management, Farming Practice, Agricultural Anthropology.*

ОҢТҮСТІК-ШЫҒЫС ҚАЗАҚСТАННЫҢ ЖҮГЕРІ АЛҚАПТАРЫНДА ЖЕРДІ ТҰРАҚТЫ БАСҚАРУ: ҚАЗАҚСТАН МЕН ҚЫТАЙ ШЕКАРАСЫНЫҢ ЕСЕБІ

Яги Фуки, Майра Кусаинова, Хошино Бухо

Аңдатпа. Қазақстан-Қытай шекарасын мысалға ала отырып, Қазақстанның жартылай құрғақ жерлеріндегі ауыл шаруашылығы 2010 жылдардан бастап трансформацияланды. Бұл зерттеу Қазақстанның мемлекеттік саясатына сәйкес жүгері өсіру әдістерін зерттейді, нәтижесінде тұрақты жер ресурстарын басқаруды (ЖРТБ) болашақта енгізу бойынша саяси ұсыныстар әзірленді. Негізгі респонденттермен сұхбат және статистикалық мәліметтерге шолу арқылы бұл зерттеу келесі тапсырмаларды анықтайды: 1) зерттелетін аумақта географиялық жағдайға байланысты үш ауылшаруашылығы мәселесі бар; 2) фермерлер ауыспалы егіс және органикалық тыңайтқышты (көңді) пайдалану арқасында ЖРТБ енгізу үшін жақсы ауыл-шаруашылығы тәжірибесіне ие; 3) ЖРТБ жарияланғанға дейін жүзеге асырылған ауыл шаруашылығын инвестициялау саясаты шеңберінде құрылған ауылшаруашылығы кәсіпорындары 2010 жылдардан бастап жүгері өсірудің кеңеюіне әсер етті. Бұл нәтижелер әрбір биіктікке сәйкес технологияларды енгізу және жергілікті компаниялармен бірлесіп жұмыс істеу арқылы тұрақты ауыл шаруашылығы жерлерін игеру арқылы Қытай мен Қазақстан арасындағы инфрақұрылымның дамуына әсер ететін зерттелетін ауданда ауыл шаруашылығы өндірісін тұрақты түрде жақсартуға болатынын көрсетеді.

Түйін сөздер**:** *Қазақстан, шекаралас аймақтар, жартылай құрғақ жерлер, ауылшаруашылық тәжірибесі, ауылшаруашылық антропологиясы.*

УСТОЙЧИВОЕ УПРАВЛЕНИЕ ЗЕМЕЛЬНЫМИ РЕСУРСАМИ НА КУКУРУЗНЫХ ПОЛЯХ ЮГО-ВОСТОЧНОГО КАЗАХСТАНА: ОТЧЕТ С ГРАНИЦЫ КАЗАХСТАНА И КИТАЯ

Яги Фуки, Майра Кусаинова, Хошино Бухо

Аннотация. Сельское хозяйство в полузасушливых землях Казахстана на примере Казахстанско-Китайской границы преобразовывается с 2010-х годов. В этом исследовании рассматриваются методы выращивания кукурузы в соответствии с государственной политикой Казахстана,, а также даются рекомендации по вопросам политики для будущего внедрения устойчивого управления земельными ресурсами (УУЗР). Путем интервью с клю-

чевыми опрашиваемыми-фермерами и обзора политических документов в этом документе определяется следующее: 1) на исследуемом участке есть три сельскохозяйственных проблемы в зависимости от географического расположения; 2) у фермеров есть положительная сельскохозяйственная практика для внедрения УУЗР, такая как севооборот и использование органического удобрения (навоза); и 3) сельскохозяйственные предприятия, созданные в соответствии с политикой сельскохозяйственных инвестиций, повлияли на расширение выращивания кукурузы с 2010-х годов. Эти данные свидетельствуют о том, что можно устойчиво улучшать сельскохозяйственное производство в районе исследования, на которое влияет развитие инфраструктуры между Китаем и Казахстаном, путем внедрения соответствующих технологий для каждой возвышенности и развития устойчивых сельскохозяйственных угодий посредством сотрудничества с местными компаниями.

***Ключевые слова*:** *Казахстан, приграничье, полузасушливые земли, устойчивое управление земельными ресурсами, сельскохозяйственная практика, сельскохозяйственная антропология.*

Introduction

Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan) has a largely arid and semi-arid climate, and local farming is vulnerable because of low year-round precipitation and aridity [1][2]. Soil degradation and salinization of irrigated cropland are major problems of dryland agriculture [3]. Solving these problems requires examining not only the environmental aspects, but also the social, economic, and cultural aspects of the region. Therefore, the adoption of Sustainable Land Management (SLM) is expected [4] [5] [6] [7].

SLM requires the introduction of technologies appropriate to each region according to the socio-cultural elements of farming (farming knowledge and technology) [8] [9]. SLM comprises the dissemination and implementation of technologies that combine a sustainable ecosystem with increased yields. These technologies are said to be more effective when based on locally systematized farming techniques and knowledge [10]. Therefore, SLM can be introduced by focusing on specific farming practices while promoting SLM as a policy [11, p.50] [5, p.223]. A holistic analysis of these macro and micro practices is important for proper SLM implementation.

Farming practices in the drylands of Central Asia historically followed top-down policies and technology from the Soviet Union. During the socialist period, collective farms (kolkhoz) were established in various regions to promote the collectivization of agriculture [12, p. 40][13]. This was a large-scale promotion of agriculture based on local livelihoods (irrigation, rain-fed, or pastoral), with the state providing agricultural technology and knowledge. With the collapse of the Soviet Union in 1991, collective farms were dismantled, the property was distributed to the local population (privatization), and farming by individuals or agricultural enterprises developed [14] [15] [16, p.11]. Since the 1990s, privatization has broken the structure of uniform state support, and a farmer's access to markets and farmer-to-farmer networks has become significant. According to Toleubayev et al. [17], the individualization of farming through privatization in Kazakhstan has disconnected farmers from agricultural technology and knowledge introduced during the Soviet era.

While the agricultural sector witnessed an increase in the number of small and medium-sized farmers because of privatization, the Chinese government's Belt and Road initiative (BRI) was announced in 2013 to develop infrastructure and foreign investment in related countries. Central Asia was positioned as the first gateway of the Silk Road [18]. This will contribute to the promotion of production in the agricultural sector and promote the industry in the target areas. However, the benefits of this enhanced infrastructure will not be realized without resolving existing issues such as water resource management, salinization, and the introduction of agricultural machinery.

This paper examines farming practices and related policies in the border areas of Kazakhstan from the perspective of agricultural anthropology and makes policy recommendations for the future implementation of SLM. This will clarify what specific issues policymakers will work on and focus their investments on. Agricultural anthropology, according to anthropologist Robert Rhoades, applies the findings of cultural anthropology in society. He defines agricultural anthropology as "the comparative, holistic, and temporal study of the human element in agricultural activity, focusing on the interaction of ecology, technology, social structure, and ideology" [19, p. 46]. Building on this direction, agricultural anthropology is expected to contribute to research on sustainable agriculture under contemporary global climate change [20]. This presents a need for research that comprehensively observes farmers' practices and knowledge and aims to solve agriculture-related problems [21]. Through this discipline, a different perspective than economic indicators can be considered in the discussion of modern SLM implementation. Thus, analyzing farming practices in the drylands of Central Asia from the holistic perspective of agricultural anthropology will help to identify the agricultural factors involved in the introduction of SLM and provide specific recommendations to policymakers.

Materials and method

Research method

The research consisted of interviews and a survey of legal documents in Kazakhstan. Interviews were conducted as a preliminary study; these semi-structured interviews conducted in August 2019 with five farmers and the director of agriculture of the Panfilov District. The interviews revealed that farmers and administrators shared the relationship between farming challenges and elevation. Based on this, key informant farmers were identified from interviews with farmers in the wider Zharkent area as a preliminary survey in December 2019. The criteria for key informants were the following: (1) location and elevation of farmland, (2) having at least 10 years of cropping production, and (3) ownership of the land. Semi-structured interviews were conducted with 26 key informant farmers in December 2020. The target population consisted of 24 men and 2 women; all farms were planted with corn and alfalfa. Field acreage ranged from 4 ha to 425 ha, with a mean value of 52.7 has and a median value of 13.2 ha. Informants were interviewed about their basic farming knowledge, where they sell their harvests, their current farming issues and future prospects, and the impact of the BRI. Based on these data, research on Kazakhstan's legal policy was conducted in the summer of 2022 using Adilet, an archive site of Kazakhstan's legislation. The collected materials include Kazakhstan's laws and regulations on the introduction of innovations in agriculture in Kazakhstan and the Panfilov region since the 2000s.

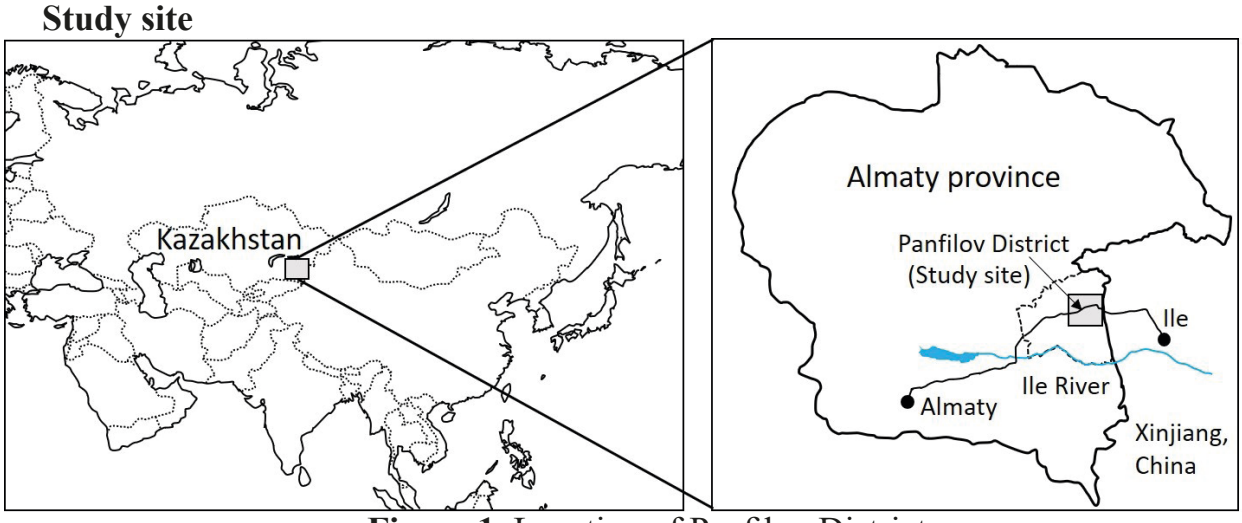

Figure 1. Location of Panfilov District

The study site is the Panfilov region, Almaty Province, Kazakhstan (Figure 1). The region comprising one town and 13 rural areas is located approximately 300 km east of Almaty, the center of southern Kazakhstan. The administrative center is in Zharkent city. It has a market and an administrative office. The area of the district is 10,600 km2. The population was 130,000 in 2020.

The Panfilov region is characterized as a transitional point between Urumqi, China, and Almaty, Kazakhstan [22] [23]. It had a closed border because of the Sino-Soviet split in the 1960s, thus resulting in development within the economic bloc of the Soviet Union. However, when the Soviet Union collapsed in 1991 and Kazakhstan became independent, the border between China and Kazakhstan was opened. The increased traffic of people and goods strengthened the district's role as a border transit area. In 2014, in relation to the BRI, the Khorgos Special Economic Zone was established in the border region between China and Kazakhstan [24], and a highway and railroad were built from Khorgos to Almaty, Kazakhstan[25, p. 26–28].

The agricultural sector in the district consists mainly of the cultivation of crops, especially corn. Originally, small-scale farming, majorly wheat, was the mainstream, but since the 1930s several collective farms were established [26 p.110]. Finally, in 1976, all the collective farms were integrated to form the "40th Anniversary of the October Revolution Kolkhoz." With its establishment, technicians were invited from the Soviet Union. Director Gorowatski from Poland directed the collective farms and encouraged corn cultivation [22, p.198]. A high-quality corn seed used in the Soviet Union was cultivated and exported to various parts of the Soviet Union via large cities in Kazakhstan [26, p.110–111]. Panfilov was located on the periphery of the Soviet Union, and collective farms' grains and vegetables were collected and treated in Zharkent and transported to other large cities in the Kazakh Republic [23, p. 374].

However, after the collapse of the Soviet Union, collective farms were privatized and their land and property were distributed to individuals. This decline in agricultural production was largely because of the impact of the privatization of collectivized property as individual property. After the breakup of the collective farm, developing private farming practices became necessary for Panfilov farmers. Farmers who could not manage their farms sold their land to farmers with capital and farmed under their management [22, p.

209–212]. Therefore, as it was reported that from the end of the 1980s to 2018, farmland gradually increased after the start of BRI, although farmland decreased significantly in the 1990s [27][38].

Agricultural land in 2019 was 44,000 ha, accounting for 4.2% of the district's area. Agricultural production was 4,665 million tenge ($111 million) in 2020, a significant increase from 2,892 million tenge ($20 million) in 2000. The farmer population, as of 2019, was 86,830. However, this includes livestock breeding and fish farming data too, and not all of them are engaged in corn cultivation [29].

Results

Agricultural calendar and irrigation systems in the Panfilov District

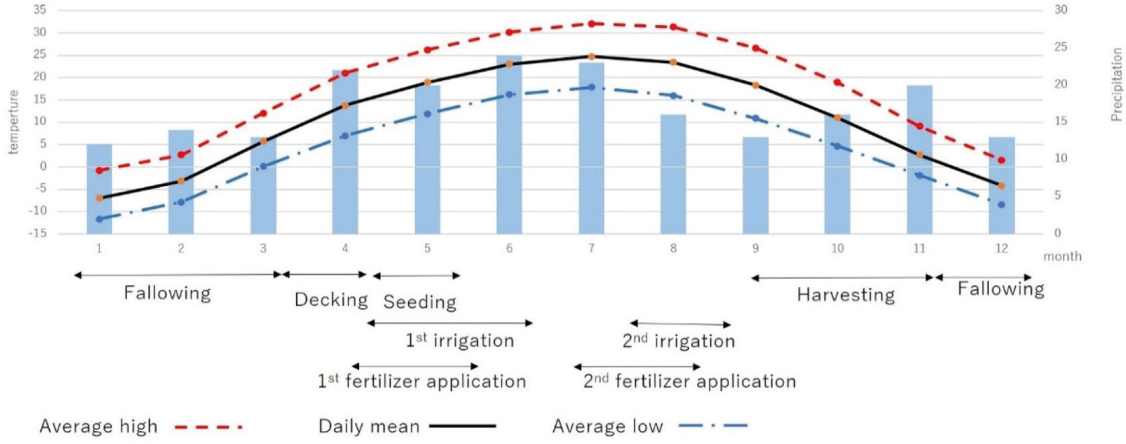

Figure 2. Agricultural calendar

In the Panfilov district, corn is farmed using water flowing from the mountains in the north. Figure 2 shows a calendar summarizing the corn farming practices of 26 farmers and the climate in the Panfilov district during the year. Corn is planted from the end of April through October and harvested once a year. At other periods of the year, average temperatures can drop below 0°F, forcing the land to lie fallow. The average seasonal rainfall is less than 200 mm.

A small amount of water that melts from winter snow is available in the spring. Since it is insufficient for the farmland, all farmers use irrigation water from the Usek River, which flows from north to south through the Panfilov district.

According to 2011 statistics, irrigated land within the Panfilov district covers 33,055 ha or 77% of the 43,000 ha that was agricultural land. A dam for agricultural water and pipes for each farmer will be installed in the northern part of Zharkent to distribute water to the eastern, central, and western parts of the district through irrigation canals. According to farmers, irrigation water reduces from mid to late April during the agricultural calendar, when all farmers irrigate their fields simultaneously. The supply of irrigation water causes delays, sometimes delaying the growing season until November.

The Panfilov district has geographic diversity that is directly related to its farming issues. Figure 3 shows a map plotting the location of the farmers surveyed in this study and the elevation of the area. The highlands of Mt. Alatau are located in the north (1000 m to 1200 m above sea level), and the alluvial fan area extends from the upper reaches of the Usek River to its midstream. The area around

the city descends from about 800 m to 600 m in elevation. In the southern part of the region, the international river, Ili, flows from Lake Balkhash toward the Chinese border. The lowlands, which are less than 600 m above sea level, lie at the confluence of the Usek and Ili Rivers.

Geography and farming issues in the Panfilov District

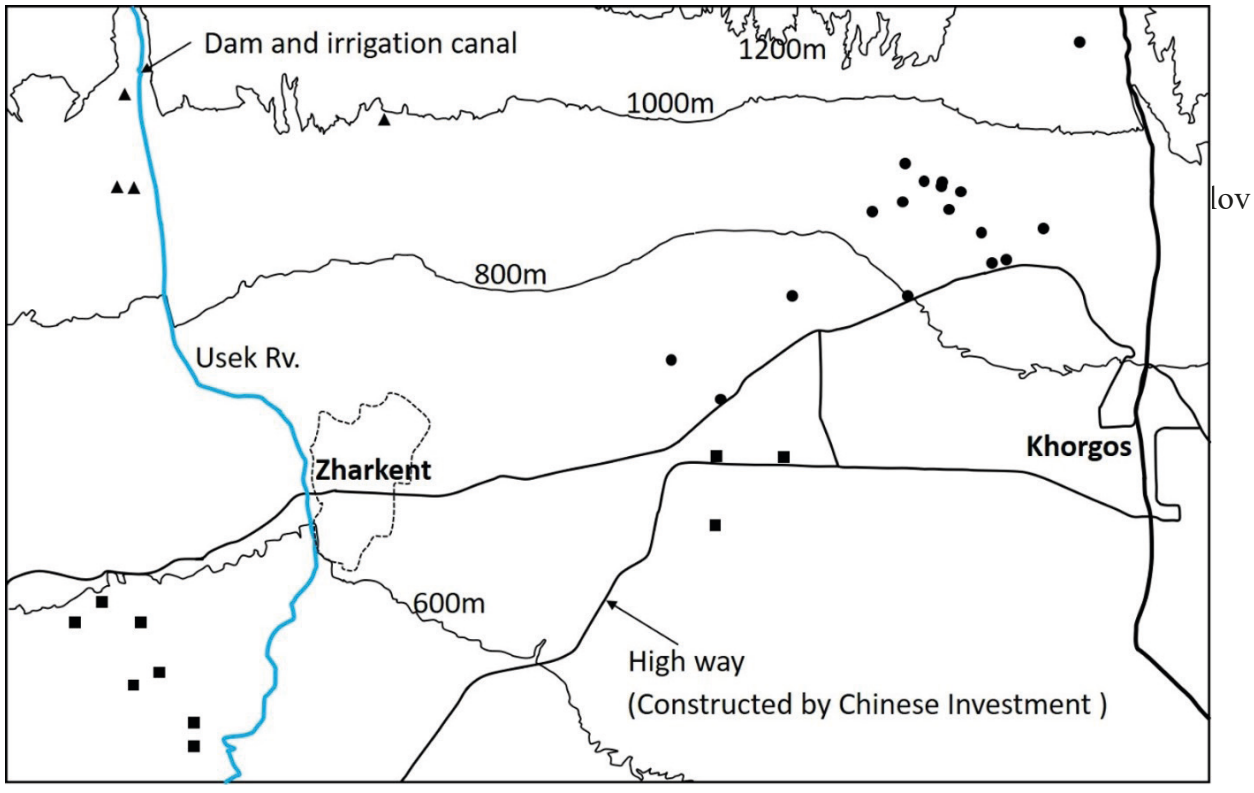

Figure 3. Map around Zharkent city. Plotted marks where farmers participated in this survey. Three marks represent each farming issue. ▲: Difficult to install machines because of rocks; ■: Soil salinization; ●: Issues related to soil degradation and fertility.

District's Agricultural Production Bureau, based on the elevation difference, three farming issues are centered on the Usek River. The upstream area from the dam on the Usek River to the city of Zharkent is an alluvial fan of Mt. Alatau. There, he said, the number of large rocks make it difficult to introduce large agricultural machinery. In contrast, in the downstream area, from the highway to the Ili River, soil salinization mainly occurs because of the rise of groundwater, making it difficult to obtain stable yields. Then, the midstream area of the river, between the upstream and downstream areas, has few rocks and salinization. However, soil erosion has occurred. Therefore, various farming practices are being implemented to increase the fertility of the land, which will respond to artificial intervention.

The most typical farming practices in the midstream area are crop rotation along with chemical fertilizers and manure usage. 26 farmers use the crop rotation because they restore land fertility by creating fallow land over approximately 3 to 10 years. Then, alfalfa is grown for multiple years and strained into the land to restore soil fertility where corn was produced. After crop rotation, organic

manure, collected from livestock manure and other sources, can be mixed. While chemical fertilizers have an immediate effect when planting corn, many farmers use manure on fallow land, resulting in high demand for this manure. According to one farmer in farming in the midstream area, he tries to collect manure from all over the district to apply 10 tons of manure per hectare. One ha of manure is equivalent to one large truck called KamAZ - the Kama Automobile Plant. The manure is applied to the alfalfa growing area and then the alfalfa is strained into the soil to restore soil fertility. Manure usage doubled some farmers' yields compared to previous years.

Development of Agricultural Enterprises and Collection of Harvests

Interviews with local farmers revealed that all farmers provide their harvest to agricultural enterprises in Kazakhstan. Approximately 80% of farmers deliver corn to the LLC "Zharkent starch and syrup factory" based in Zharkent. The remaining 20% of the harvest is supplied to other agricultural enterprises in the Almaty Province.

Zharkent starch and syrup factory had been the largest state-owned corn starch plant in Central Asia since the socialist period but stopped operations with the collapse of the Soviet Union in 1990. The plant restarted in 2006. Currently, the company produces cornstarch with modern equipment and sells it to businesses, expanding its sales channels to domestic companies in Kazakhstan as well as to Uzbekistan, China, Russia, and other countries. The company's facilities began to be fully equipped in 2013 when government support for small and medium agricultural enterprises in Kazakhstan was enhanced. That year, the company worked with a major Turkish company to build a modern cornstarch production plant. Furthermore, in 2017, the company started refining sugar along with cornstarch production [30].

The development of this enterprise is strongly related to the Kazakhstan government's support for agricultural enterprises. In the late 2000s, the Kazakhstan government announced a government policy of modernizing agricultural technology for stimulating domestic investment [31], and in December 2012, then Kazakhstan President, Nursultan Nazarbayev, announced the "Kazakhstan 2050" strategy. This is an expansion of the Kazakhstan 2030 political and economic strategy declared by the Kazakhstan government in 1997 and was announced as a national strategy that defines a wide range of political and economic sectors until 2050. In the "Kazakhstan 2050" strategy, President Nursultan Nazarbayev referred to the modernization of the agricultural sector and the increase of productivity through technological innovation [32]. This strategy includes the following: significant increase in crop yields through the introduction of new technologies; production of world-class livestock feed; development of environmentally friendly and competitive brands; introduction of modern technologies for processing and development of small- and medium-sized enterprises that process and trade agricultural products; and formulation of a processing lineup. In implementing these measures, a new development program for the agricultural sector until 2017, "On Approval of the Program for Development of Agro-Industrial Complexes of the Republic of Kazakhstan 'Agribusiness-2017,'" was adopted [33]. It included the establishment of a legal and economic incentive system for the establishment of large agricultural enterprises and an increase in the tax rate on undeveloped land for a certain period.

These domestic laws have created momentum for the export and production of processed products abroad, but with the

cooperation of local farmers. Along with the "Kazakhstan 2050" strategy, Zharkent starch and syrup factory processes 350,000 tons of corn annually and sells 60% of the processed items to domestic companies and the remaining 40% to companies in Russia, China, Kyrgyzstan, Uzbekistan, and Tajikistan [34].

In collaboration with local farmers, the company provides technology and supplies to farmers, who then process the harvest at their factories. About half of the 350,000 tons of corn to be treated at the plant comes from 130 local farmers. Service and harvest centers were established in the Zharkent. Farmers come in the fall with their harvest and receive their reward payment. The company also provides supplies to farmers, including subsidized seeds, herbicides, mineral fertilizers, and diesel fuel [35].

Farmers' Narratives related to BRI

The Panfilov district is located in the border region between China and Kazakhstan and has been affected by the investments associated with the BRI. Interestingly, the results of the survey showed that more than 80% of respondents had no impact related to the BRI. One partial effect on some farmers is the highway that crosses the southern part of the Panfilov district from Khorgos, thus dividing the originally single farmland parcel into north and south sections. The highway was built with infrastructure investment by China, connecting Khorgos to Almaty and significantly shortening the travel time. Since the highway is protected by guardrails, a large detour is required to cross it.

Furthermore, the highway was constructed at a higher elevation than the normal land level, thus improving the additional soil and infrastructure. However, it is said that the construction of the highway will cause the groundwater in the farmland around the highway to rise, resulting in poor drainage of the farmland. Thus, the development of infrastructure by the Chinese government is found to have affected the physical movement and drainage of farmland.

Discussion

SLM practices are necessary for Central Asian drylands to improve land yield in response to soil degradation caused by climate change. Several factors impede the diffusion of the technology, which is still under development. Among these factors, common to all regions were the lack of information about SLM locally, limited access to markets, and agricultural policies driven by short-term profits [5] [11]. However, the factors that aid SLM adoption include improved access to markets, access to extension, and learning and information exchange about SLM with other farmers [46].

According to the agricultural anthropological survey, this paper reveals that some of the drivers indicated by Mirzabaev et al. [36] are already in practice in the study area. It was also included in the concepts for the development of the agro-industrial complex of the Republic of Kazakhstan for 2021 – 2030 [37]. Farmers' practices were found to explore sustainable land use in a different context than SLM implementation. Crop rotation and organic manure usage in midstream areas contribute to improved land and water management in SLM, as mentioned by Pender et al. [38]. Therefore, by basing their findings and conventional practices, farmers can smoothly implement SLM.

It is important to appropriately address the different farming issue at each elevation as follows as recommendations for policy. Since the upstream area is inaccessible to large machinery, it is necessary to introduce ICT-based agriculture as an alternative to large machinery. In the midstream area, the

soil environment is relatively good, and there is a need to cultivate commercial crops and to promote test plots for new technologies in large-scale projects. In the downstream area, there is concern about the soil salinization due to poor drainage. Therefore, it is recommended that measures be taken to avoid soil degradation while not reducing productivity by improving drainage and introducing irrigation technology. In addition, innovative projects that address such issues could be facilitated. Although there are currently no outstanding issues regarding the distribution of water resources, future expansion of agricultural production may cause problems in the use of water resources, and future trends should be closely monitored.

It is necessary to share these visions with companies that are partnering with agriculture (e.g., cornstarch factories) and jointly develop them in an environmentally friendly way. Regarding these prosecess, the connection between agricultural enterprises and farmers could also positively affect the adoption of technology. The support measures for technological modernization for agricultural enterprises that began in Kazakhstan in the 2010s created a network of farmers in the Panfilov district to bring their harvests to neighboring factories, which has proven to be the basis for creating mutual information and technology exchange between agricultural enterprises and farmers.

While discussing the introduction of SLM in the Panfilov region, considering the regional peculiarities in this area is important. The geographical aspects of the region cannot be ignored, as it is historically famous because it is the only region in Kazakhstan that produces corn, and the region is located on the Kazakhstan-China border. The direct BRI impact on the Panfilov region is limited to physical constraints because of infrastructure development. Therefore this paper reveals that the BRI did not dramatically transform local farming activities, rather it existed as an actor in historical activities. This is, the future studies should capture the impact of the BRI in the process of introduction of corn varieties and expansion of cultivation during the Soviet era, the privatization of collective farms after the Soviet era and the breakdown of skills and abandonment of land, and the expansion of agricultural investment and state support beginning from the 2000s (Figure 4).

Conclusion

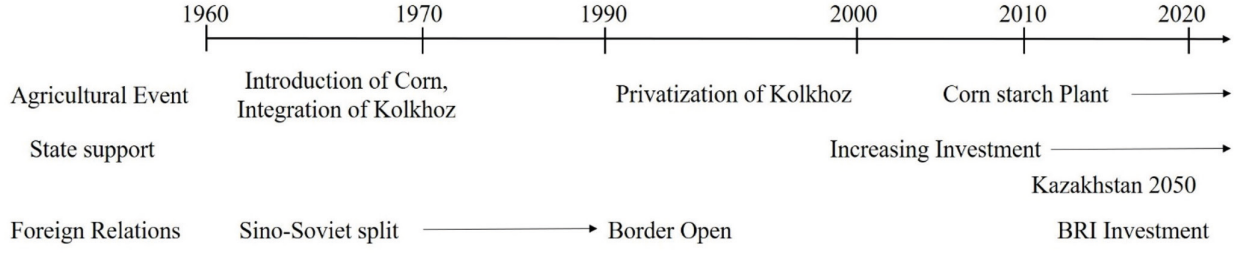

Figure 4. Chronology of historical events in the Panfilov District

This paper examined the corn farming practices and policy context in Central Asia from the perspective of agricultural anthropology and makes policy suggestions to promote SLM in the future. Corn agriculture in Kazakhstan has been revitalized by policies implemented since the 2010s to promote domestic agriculture. The BRI is positioned as one of the many local agricultural events and will have an impact along with domestic agricultural policies in the future.

SLM has contributed to rural development

around the world by launching agricultural sustainability. The arid lands of Central Asia are directly vulnerable to the effects of climate change. Therefore, rural development in this region must be based on an understanding of the farming practices in the target area and on-the-ground knowledge to determine their implementation feasibility in the long term. This is because they are directly related to farmers' practices and are drivers of their transformation. By focusing on state policies and international relations related to local agriculture, the various stakeholders involved can be identified. Furthermore, visualizing the network of diverse stakeholders will facilitate appropriate technology adoption and land management based on their involvement with farmers.

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