

# Seeds of empire or seeds of friendship? The politics of the diffusion of Chinese cotton seeds in Tajikistan

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## Abstract

China's nascent role in the global agrifood regime manifests itself in varied ways across the world, including in the rising spread of Chinese agricultural inputs in foreign markets. This article examines the character and dynamics of a Chinese seed company in Tajikistan, a country in which China's influence has grown substantially since the early 2010s. Focussing on Tajikistan's politicized cotton sector, I analyse the multiscalar and multiactor processes involved in the promotion of Chinese cotton seed and illuminate that Chinese seed breeders strategically tapped into Chinese state funds for their commercial seed business. However, Tajik actors as well as socio-economic, technical, and political factors have played a crucial role in mediating the Chinese presence and the commodification of seed. I contend that Tajik farmers' seed selection is not significantly influenced by, what could be called, grand politics. Furthermore, I demonstrate that, while the Chinese state plays a central role in the globalization of seed companies, the materialization of state capital has been shaped by private actors, who operate according to capitalist rationality.

## KEYWORDS

agrifood regime, Global China, political economy, seed politics, Tajikistan

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## 1 | INTRODUCTION

A visit to an agricultural input shop in rural Tajikistan overwhelms a visitor, with its shelves stuffed with colourful packages of various kinds of seeds and agrochemicals. From small tins of German-branded watermelon seeds to 25-kg bags of Chinese hybrid maize seed: the assortment appears rich. The import of seed from China has increased in recent years, and the growing availability of Chinese-origin farm inputs, such as seed, is one prominent way in which “China” has penetrated Tajikistan’s countryside from the early 2010s onwards. The discussions among various actors in Tajikistan, regarding China’s growing presence in agrifood markets, resonate with debates in global policy circles.

For both political and economic reasons, Chinese actors’ footsteps into foreign seed markets are followed with anxiety across the world, by actors from diverse, not necessarily allied, quarters. To start with, foreign states, primarily from the Global North, fear China’s rise. Indeed, concerns about economic espionage, control of genetic material, and the “weaponization of agricultural IP” (Richardson, 2022; see also Polansek, 2023) surface regularly, also in the context of China’s growing representation in UN bodies, including the UN’s Food and Agriculture Organization (FAO) (Baumann et al., 2022). A supposed “otherness” of “China” also regularly comes to the fore, as if Chinese are “more foreign than other foreigners” (Hofman, 2016a; Lu, 2021). Second, transnational “agri-powers” vie with Chinese companies for control over agrifood chains. After all, the worldwide trade in seed has developed into a highly lucrative business in recent decades, and corporate control has accelerated (ETC Group, 2022; Kloppenburg, 2010). Third, for seed and food sovereignty movements, Chinese companies’ entrance into the global seed market adds to their existing concerns (ETC Group, 2022; Grain, 2024). These three competing perspectives are focussed on the macro-level. One wonders: where are the world’s agricultural producers, as a fourth yet highly heterogeneous group of actors, positioned in these debates? This perspective remains little explored. Does it matter for farmers what kind of agribusiness assumes control over their agrifood markets? That is, is Chinese capital qualitatively distinct? How does China’s expansion in global agriculture manifest itself on the ground? Are Chinese actors sowing the seeds of empire, seeds of change, or seeds of friendship?

These questions form the backbone of this article. Chinese actors increasingly try to set the terms of engagement in global affairs. China’s development into an agri-power has given rise to a new era in the geopolitics of agriculture. Engaging the scholarship in critical agrarian studies, seed politics (Dowd-Uribe, 2014; Flachs, 2019; Glover et al., 2020; Luna, 2020), and Global China (Green, 2022; Klinger & Muldavin, 2019; Lu, 2021; Oliveira, 2019), I examine China’s growing assertiveness in foreign agrifood markets through the lens of a case study of a Chinese company engaged in seed breeding in Tajikistan.

In the early 2010s, two Chinese brothers identified Tajikistan as a seed frontier. As one of them narrated (interview 30 October 2023), the two were entrusted by the Chinese state to complete an agricultural cooperation project, and they signed an agreement with Tajikistan’s Ministry of Agriculture in 2011. The initiative materialized into two companies: an enterprise focussed on vegetable production, and a company engaged in the production of cotton and the breeding and sales of maize, wheat, and cotton seeds, which are key crops in Tajikistan. According to my knowledge, it was the first, and until the early 2020s remained the only, foreign investor that started operating in Tajikistan’s seed sector on the ground, and also the only company that engaged in hybrid seed production, as described later. The enterprise enjoyed quite some support from the Chinese as well as the Tajik state, and, in 2017, Tajikistan’s president Emomali Rahmon renamed one of the company’s cotton varieties into *Dusti-1*, which means “Friendship No. 1.”

In this article, I focus my analysis on the diffusion of Chinese cotton seed in Tajikistan. Cotton is known in Tajikistan as the state’s wealth (*boygarii davlat*) (Boboyorov, 2013; Hofman, 2018). Cotton is Tajikistan’s primary agricultural export commodity, and the cotton economy is controlled by the ruling regime (Boboyorov, 2013; Hofman, 2018, 2021c). In recent years, the state has actively attempted to attract foreign investors to revive the cotton sector (Hofman, 2021b). One wonders how Chinese seed travels in this politicized landscape, particularly given China’s weight in the country. China’s footprint in Tajikistan has significantly increased since the late 2000s (Kassenova, 2009), and the diversity and number of Chinese actors has also grown substantially. The development

has picked up speed since the launch of the Belt and Road Initiative (BRI) (Hofman, 2022). In 2015 loans “represented 53% of [Tajikistan's] total external public debt” (World Bank, 2016, p. 1), and at the end of 2022, almost 31% of Tajikistan's external debt was owed to China (World Bank, 2023, p. 22). Whilst Chinese actors' direct engagement in Tajikistan's rural economy is confined to the southwestern region (see also Hofman, 2021c), across the country Chinese companies are involved in various sectors of the economy. A highly visible and eye-catching manifestation of the Chinese presence is Tajikistan's new governmental and parliamentary buildings, which have been financed and constructed by the Chinese state and Chinese companies. As a result, the case of Tajikistan offers a perfect lens to analyse the politics and characteristics of Chinese agribusinesses' expansion in foreign seed markets. Changes in seed use have the potential to reflect broader, macro-level trends. After all, farm fields have always been political domains. They are arenas in which the interests of a wide spectrum of actors are played out.

The body of scholarship on Global China has grown considerably in recent years in terms of approaches, discourse, and detail. Yet, some caveats remain. For one, many studies on China's influence in the global agrifood regime analyse global or meso-level dynamics (Belesky & Lawrence, 2019; McMichael, 2020). Second, and relatedly, the popular opinion, as well as a part of the scholarly attention, continues to return to stereotyping China and polarized conceptions of China (for critique, see also Klinger & Muldavin, 2019; Lu, 2021).

Multiscalar, qualitative, grounded approaches are essential in order to shed light on the politics and processes that allow Chinese actors to go global (see also Green, 2022; Klinger & Muldavin, 2019; Lu, 2021). Ethnographies and micro-level analyses can illuminate whether, how and to what extent various actors and locally specific factors (e.g., material and environmental) shape the materialization of plans on the ground (see also Chen, 2021; Loughlin & Grimsditch, 2021; Oliveira, 2019). Micro-level dynamics reflect macro-level trends, yet also constitute the latter. Oliveira's (2019) account of Brazilian brokers and bureaucrats, who shaped Chinese agribusinesses' development in Brazil, and Chen's (2021) analysis of the role of the leader of a Chinese diaspora association in Laos attest to the need for ethnographic accounts. The case study in this article sheds light on Chinese actors who actualized “policies associated with China's global integration” (Klinger & Muldavin, 2019, p. 6), by establishing an agribusiness in Tajikistan.

There have been very few ethnographic studies on the spread of Chinese agricultural inputs in foreign economies, and scholarly work has mainly focussed on dynamics in African countries (Bräutigam, 2015; Buckley, 2013; Xu et al., 2016). Yi et al. (2020) examined agricultural technology transfers between Chinese and Russian farm enterprises, predominantly using quantitative methods. Notably, state-initiated agricultural training centres, as seen in Africa under the framework of the Forum on China-Africa Cooperation (FOCAC), do not exist in Central Asia, and, compared with other (sub)continents, the Chinese presence in Central Asia is relatively young, despite the fact that the region borders China.

In the following parts of this article, I depart from the macro-level of China's growing role in global agriculture and go down to Tajikistan's countryside, where I analyse developments chronologically from the 1990s until the early 2020s. In the next (second) section, I describe the methodology. In section three, I review the literature on Global China, seed adoption, and seed selection practices. I accentuate the overlap between the factors affecting seed adoption and the factors influencing the unfolding of Chinese investments in foreign markets. The fourth section introduces the case study and historically contextualizes dynamics in Tajikistan's seed sector, with a focus on cotton. The fifth section contains the heart of the empirical analysis. I examine the politics of the diffusion of Chinese cotton seed in Tajikistan. In the sixth section, I conclude. Whereas concerns over China's influence in Tajikistan are often foregrounded by political analysts and popular media, I spotlight that both the spread of Chinese seed and seed adoption are shaped by multiple actors and conditions. Tajik farmers' decision-making does not appear to be significantly influenced by, what could be called, grand politics. Furthermore, the Chinese seed breeders analysed in this article strategically tapped into the resources provided by their state. Indeed, individuals shape the ways in which Global China materializes on the ground, where various dimensions of the foreign (rural) landscape play an important role.

## 2 | METHODOLOGY

This article is based on a lengthy period of 20 months of fieldwork (2020–2021) in Tajikistan, with a few more recent insights obtained during a short visit in 2023, when I was undertaking an EU-financed study in Tajikistan focussed on the cotton value chain, and conversations with key informants in October–December 2022, January 2023, and September and October 2023, by telephone and WhatsApp. This article also builds on earlier periods of fieldwork in Tajikistan (2012–2015). I used a multisited, multiscalar research approach and mainly relied on qualitative methods. This allowed me to adopt a grounded approach to analyse Global China (cf. Klinger & Muldavin, 2019; Lu, 2021).

I commenced fieldwork in the first week of January 2020 and decided to stay when Covid-19 spread to Tajikistan. Fieldwork during the pandemic was challenging and required constant adaptation. In contrast to many other countries, the Tajik state did not impose a lock-down. However, I took precautionary measures, adhering to ethics and the University of Oxford's Covid-19 regulations. I paused in-person interactions in urban and rural areas for a few months (from late April through to June). From July onwards, taking precautionary measures, I returned to residing in rural areas and visiting rural households in four districts in southwest Tajikistan, and frequented three Chinese company bases and surrounding fields almost weekly at the height of the cotton season, where I mingled with personnel. I also visited the seed processing base of the company studied in this article. While only this latter location and one of the three other locations were bases of this specific company, the various conversations on and around all bases were of great importance to understanding overall dynamics regarding the activities of Chinese companies, and the Chinese companies' interactions with Tajik farmers and the Tajik state. In total, I held 92 open-ended and semistructured interviews with a variety of actors. One in-depth interview was carried out with the Chinese company director whose work and ambitions are analysed in this article (October 2023, by telephone, in English). Furthermore, 15 interviews were carried out on the Chinese farm bases, with Tajik base managers, Chinese directors, Chinese agricultural specialists, Tajik agronomists, and translators (who also held managerial roles). These conversations did not always explicitly address seed issues and did not always refer to the company analysed in this article, but they provided essential insights into the characteristics and dynamics of the Chinese agribusinesses. I carried out 38 open-ended interviews with farmers and rural households engaged in cotton production; four interviews with employees at seed-breeding farms; 15 interviews with state officials of the Ministry of Agriculture (at various levels of the administration); and, 19 semistructured interviews with seed specialists and scientists, of which three took place by telephone in December 2022, January 2023, and October 2023. I also participated in a public event on the seed sector in December 2020 and visited three of the four research stations of the Tajik Academy of Agricultural Sciences. These various meetings and interviews focussed on land and seed politics, the seed trade, and the history, agronomy, and politics of cotton, as well as of agricultural development, broadly defined. In February 2021, I also carried out a farm survey with two assistants. This survey was orientated towards land reform dynamics ( $N = 233$ , of which 155 farmers were engaged in cotton farming) in the district where the company analysed in this paper was located and included eight questions on seed selection. While not representative, the data give insights into seed selection practices and selection criteria. The article also draws on media analysis (in English, Chinese, Russian, and Tajik) and various secondary sources, for instance, the Tajik state's registry of certified seeds (Ministry of Agriculture, 2021), and documents of the company studied in this article (e.g., seed certificates and documents of establishment). Furthermore, in 2021, I conducted research in the Central State Archive of the Republic of Tajikistan, in Dushanbe. I was able to access archival material on agricultural developments in Tajikistan from the early 20th century to the late 1990s. I do not explicitly refer to archival documents in this article, but the archival research was of great help in order to historicize developments, as well as to engage in informed discussions with farmers, officials, and scientists in Tajikistan. Thus, I used mixed methods. I predominantly worked alone, being fluent in Tajik. To communicate with non-English speaking Chinese actors, I asked Chinese acquaintances and company translators around field sites to assist me. I was supported by assistants for the survey (as mentioned above), as well as for archival research.

It must be noted that undertaking academic research as a foreigner in Tajikistan is no sinecure. My research in 2020–2021 benefitted substantially from the networks and rapport I had built in earlier periods of fieldwork. However, ethnographic research with a focus on cotton and the Chinese presence in Tajikistan is particularly challenging, as both are highly politicized themes. For that reason, I was not able to undertake a large representative survey. Furthermore, triangulating sources, as well as protecting the identity of sources, present challenges to research ethics because Tajikistan's seed sector, and the circle of key actors in the agricultural economy as a whole, is small, in an overall very small country.

### 3 | SEED AS SOFTWARE OF AGRICULTURE

#### 3.1 | Chinese companies entering foreign agrifood markets

*“Seeds are known as the ‘chips’ of agriculture [...] For [China], the status of seeds is not limited to agriculture. [Seeds are] also an important bargaining chip to ensure national food security” (Wang, 2021).*

The seed sector is of great importance for the Chinese state, owing to the importance attributed to food security and self-reliance (Gaudreau, 2019; Xu, 2022). In 2021, the Chinese government adopted a plan to revitalize the seed industry (Ministry of Agriculture and Rural Affairs, 2021), as well as a plan for the bioeconomy (National Development and Reform Commission, 2021). The goal to make use of international markets and actively participate in the formulation of international agricultural policies and standards is explicitly stated in the “National Agricultural Sustainable Development Plan (2015–2030)” (Ministry of Agriculture and Rural Affairs of the People's Republic of China, 2015, p. 32).

In the globalization of Chinese agribusinesses, political and economic imperatives intertwine. The increasing presence of Chinese actors in the global seed market is characterized by a multipronged approach. For one, Chinese state-owned enterprises (SOEs) are going global (Gaudreau, 2019). They often do this by acquiring existing, transnational corporations. Through these acquisitions, they have joined the arena of other “gene giants” (cf. Kloppenburg, 2010) or global “food barons” (ETC Group, 2022). Since ChemChina's acquisition of Syngenta and the “supersized consolidation” (ETC Group, 2022, p. 16) of SinoChem and ChemChina, China's role in the global agrifood market has substantially increased (Belesky & Lawrence, 2019; Xu, 2022). In 2022, SinoChem Holdings Cooperation controlled almost 25% of the agrochemical market (ETC Group, 2022, p. 14) and 7% of the global seed market (ETC Group, 2022, p. 16). Second, smaller Chinese companies are venturing into foreign seed sectors. Furthermore, import requirements set by the Chinese state and Chinese companies have also, indirectly, affected foreign agricultural sectors (Gaudreau, 2019; Green, 2022).

#### 3.2 | Taking root in soils and in markets

Whereas the global trade in seed has accelerated in recent decades (Kloppenburg, 2010), seeds do not travel and root autonomously. First, they need carriers, such as the wind, birds, or actors. Second, once landed, seeds need a conducive environment to germinate and mature. Like IT software, that is not necessarily compatible with hardware, seed does not take root in any random soil. Seeds resemble, or bear,<sup>1</sup> technological standards. As highlighted in various studies on seed adoption (Dowd-Urbe, 2014; Schnurr, 2012; Stone & Flachs, 2018), the “practical, biological, political-economic, regulatory and institutional factors” are salient in shaping the diffusion and adoption of seed (Glover et al., 2020, p. 13). “[C]rop seeds are the product of complex sociotechnical contexts, encapsulating political agendas and social struggles,

<sup>1</sup>I thank Miriam Driessen for this note.

as well as adaptation to and collaboration with a range of human and nonhuman actors in the local environment” (Bray et al., 2019, p. 26). Thus, “hardware” does not only encompass the soil and material artefacts.

Specific segments of seed markets may involve different degrees of liberalization, and the technologies and practices applied for specific crops, as well as the values underpinning farmers' seed selection, tend to differ (cf. Flachs & Stone, 2019). Foreign agribusinesses entering new terrains confront such convoluted landscapes. Local intermediaries or extension agents can facilitate the proliferation of seed by establishing connections and sharing insights into the “socio-spatial context of adoption” (cf. Schnurr, 2012, p. 785). Likewise, local experts can support Chinese companies venturing overseas. Indeed, the factors affecting the adoption of seed, and the factors influencing a Chinese company's successful entry into a market, partially overlap.

A growing body of research on Global China addresses the crucial role of local brokers, intermediaries, and specialists, in the development of Chinese enterprises operating in foreign economies (see, for instance, Chen, 2021; Driessen, 2022; Oliveira, 2019). Local businessmen (Oliveira, 2019) or “local Chinese” (Chen, 2021) may be crucial to gain access to natural resources and understand market characteristics. Navigating the bureaucracy and legal landscape may necessitate the recruitment of trustworthy lawyers (cf. Driessen, 2022). Mediators can also be essential to cope with contingencies that appear along the way. After all, societies and economies are ever mutating, as are “cropspace,” defined by Bray et al. (2019, p. 20) as the “ever-mutating ecologies, or matrices, comprising assemblages of nonhumans and humans, within which a particular crop in a particular place and time flourishes or fails.” In turn, seeds, crops, and companies affect the socio-cultural and socio-economic environment in which they settle and become embedded (see also Schnurr, 2012).

In the following sections, I shed light on various contextual factors that affected the development of a Chinese company engaged in seed breeding in Tajikistan. While the company adjusted its approach and increasingly came to rely on Tajik brokers to facilitate the diffusion of seed, specific financial, technical, and political hindrances to succeed remained.

## 4 | TAJIKISTAN: A SEED FRONTIER

### 4.1 | Entering the frontier

The agricultural sector is of great importance for Tajikistan's economy. Together, agriculture and forestry contribute to over 20% of Tajikistan's gross domestic product (GDP). While labour migration is a prominent source of livelihood, and remittances are the backbone of Tajikistan's economy, according to national statistics over 60% of the population is employed in agriculture (TajStat, 2018, p. 55).

The Tajik state has an explicit agenda to transform the agricultural industry into an industrialized agricultural sector (see also Ministry of Agriculture, 2023). To this end, it actively aims to attract foreign investment. In recent years, the state has strongly relied on donor funds with donors contributing to over 50% of costs on various interventions in the agricultural sector (Ministry of Agriculture, 2023).<sup>2</sup> Foreign private investment in Tajikistan's agrifood sector remains insignificant.<sup>3</sup> One of the first foreign, commercially orientated actors to gain a sustained and prominent presence in Tajikistan's seed sector was the Chinese company analysed in this article.

In 2011, in a period in which China's domestic seed sector was characterized by overcapacity and excess production (Xu, 2022), two brothers, from now on referred to as the Gu brothers,<sup>4</sup> reportedly identified Tajikistan as a new agricultural frontier, in particular a seed frontier. The brothers registered a joint venture in Tajikistan in 2011.

<sup>2</sup>Of total governmental spending on the agricultural sector, the seed sector received on average 1.3% (2015–2019) and 0.7% of donor spending (2016–2020) (World Bank, 2021b, p. 78).

<sup>3</sup>What is more, “the volume of investments directed to agriculture [is less] than 3% of the total investments in the economy as a whole ...” (Ministry of Agriculture, 2023, p. 67).

<sup>4</sup>I use pseudonyms to protect anonymity, although some names have been widely stated in Chinese and Tajik media, and even though some of the individuals agreed to use their names.

The two were pioneers in various ways: their company ventured into Tajikistan before the Chinese presence in the country gained pace, with the launch of the BRI in 2013, and years before Chinese SOEs became major players in the global agrifood market (ETC Group, 2022).

One brother, according to company employees, was a former state official (interviews 16 November 2020; 24 April 2021), the other was a seed breeder. The latter's life was devoted, as he said (interview 30 October 2023), to the “breeding of new varieties, [and] the production, processing and promotion of seeds.” The Gu brothers' careers resemble developments described by Xu (2022) and Xu et al. (2016). In recent decades, seed sector reforms in China have enticed seed specialists and government workers to engage in corporate seed businesses to capitalize on their networks and expertise.

From the outset, the structure of the joint venture was complex. According to Chinese media, information on the company's website, billboards alongside the fields, and information provided in interviews, various Chinese authorities were involved: the Chinese Ministry of Foreign Affairs, the provincial authorities of Henan, and the government of the Xinjiang Uygur Autonomous Region. Tajikistan's Ministry of Agriculture was involved too. The project was implemented by a state-owned farm, from the province of Henan, together with a corporate seed enterprise from the same province (see also Hofman, 2016b). A private enterprise from Xinjiang supplied the irrigation technology. Thus, the joint venture involved various public and private actors, who offered various resources. The state-private character of the joint venture demonstrates the “‘state-capital’ nexus” (Belesky & Lawrence, 2019, p. 1122) that characterizes the Chinese economy. The specific roles and the relative contribution of all actors is difficult to indicate, particularly with regard to the Chinese actors involved.

In Chinese media, the initiative became referred to as the “China-Tajikistan Agricultural Science and Technology Demonstration Centre.” On the ground, the project materialized in two enterprises, as mentioned in the introduction of this article. One company focussed on the production of vegetables in greenhouses, that were sold on urban markets in Tajikistan. The other company focussed on the large-scale production of cotton, and the testing, breeding and sales of cotton, wheat, and maize seed.<sup>5</sup> In what follows, I focus solely on the latter company, and refer to the company as “Dahe Zhongzi Ltd” (a pseudonym).<sup>6</sup> Dahe Zhongzi Ltd's selection of cotton, wheat and maize relates to the fact that the crops are primary crops in Tajikistan's lowlands, with relatively high and constant sowing rates (see also FAO, 2021). These crops are also important crops in the company's place of origin (Henan province).

In this article, I foreground dynamics revolving around cotton for two reasons. For one, cotton is Tajikistan's primary agricultural export commodity and represents about (a relatively stable) 10% of export earnings (World Bank, 2023; see also Hofman, 2018). It is connoted as Tajikistan's “state's wealth” (*boygarii davlat*). The area allocated to cotton production (exclusively irrigated) has declined since 1991, from over 35% of all arable land in 1991 (299,000 ha), to 22% (186,000 ha) in 2019 (TajStat, 2020). The cotton sector is officially liberalized, but it is controlled by political and economic elites who have been playing a significant role in shaping reforms of the cotton sector since the 1990s (Boboyorov, 2013; Hofman, 2018, 2021c; Hofman & Visser, 2021). The Tajik state continues to disseminate production plans from the top down. While the production plans do not only concern cotton, the crop tops the plan in many lowland localities, and in some lowland areas farmers are forced to plant cotton on 60% to 70% of their farmland (Hofman, 2021c). Land is state-owned in Tajikistan, and fulfilment of production plans is important for security of tenure (see also footnote 21).

Over the years, particularly since the late 2000s, the Tajik state has attempted to attract foreign capital to revive the cotton economy. This has become more urgent since cotton sector reforms in 2009, which meant an end to the nation-wide contract farming system that had characterized the cotton sector for more than a decade (the so-called

<sup>5</sup>Interaction between the companies was close at the start. However, as time passed, the companies increasingly operated as independent units.

<sup>6</sup>Dahe Zhongzi Ltd initially cultivated land in two districts in Tajikistan's southwestern Khatlon region, but left one of the districts at the end of 2013. For seed processing, it built a seed processing base in another district in 2013 (see also Hofman, 2016b). For hybrid maize seed production, the company also leased a plot of land in a district in northern Tajikistan for a short period of time. The other enterprise engaged in the JV was based in only one locality. According to law, foreign enterprises can gain access to state reserve land for a period of 50 years in Tajikistan (see also Hofman, 2016b) and lease land from Tajik farmers for a period up to 20 years. Dahe Zhongzi Ltd accessed land based on different types of tenure. The total surface of farmland cultivated by Chinese enterprises in Tajikistan fluctuates (see also Hofman, 2021b). There are two other Chinese agribusinesses, partnering with Tajik ruling elites, engaged in cotton production in the Khatlon region. They have no links to Dahe Zhongzi Ltd.



“futures system,” briefly described in Section 4.2.2). With the reforms, direct finance from cotton merchants and support from foreign organizations declined. One wonders: What did the need for investment imply for the Gu brothers' plans? Were the Gu brothers allowed to operate as they wanted, as the Tajik state was looking for foreign capital injections to revive the cotton economy, in a context in which China already had substantial leverage?

A second reason to single out cotton, and exclude maize and wheat seed from the analysis, is that Dahe Zhongzi Ltd's engagement in the maize and wheat seed markets was much less prominent, less successful, and less controversial than its engagement in the cotton seed market. In what follows, I describe a few key characteristics of Tajikistan's seed sector and zoom in on cotton seed politics. The development of Dahe Zhongzi Ltd is analysed in section five.

## 4.2 | Understanding the seed frontier

### 4.2.1 | Tajikistan as a seed insecure state

Tajikistan's seed system can be characterized as two-partite. Alongside an informal seed sector, a state-controlled seed system was founded with the building of the Soviet agricultural planned economy. The breakdown of the Soviet Union and Tajikistan's Civil War (1992–97) had a huge impact on the country's rural economy (Burns, 2020; Hofman & Visser, 2021), including on the state's capacity to coordinate agricultural supply chains. A large and expanding cohort of international organizations entered Tajikistan in the 1990s, both to support a transformation towards a market economy and to provide humanitarian aid in the aftermath of the war (Hofman & Visser, 2021). From the early post-war years onwards, rural development projects have included interventions focussed on specific segments of the seed sector (FAO, 2009; Muminjanov et al., 2008). Food insecurity and poverty have remained relatively high in Tajikistan,<sup>7</sup> and the assumption that lack of quality as well as quantity of seed has been one of the primary causes of low yields (and, as a result, of food insecurity and poverty) has prompted numerous foreign organizations to engage in seed distribution, seed sector capacity building activities, and policy advice (on seed sector developments, see Husenov et al., 2021; Muminjanov et al., 2008). From the late 2000s onwards, the Tajik state has made concerted efforts to improve the seed sector in the form of seed sector development programmes (2010–2014 and 2016–2020, respectively) (see also Burns, 2020; Husenov et al., 2021).<sup>8</sup> However, in spite of all these efforts, Tajikistan's seed market has become highly import dependent, in the context of an import dependent agricultural input market as a whole (World Bank, 2021b). Imported hybrid seed varieties have increasingly replaced open pollinated varieties (OPVs) (see also Spies, 2023).<sup>9</sup> The cotton seed market is one exception, as I explain next.

### 4.2.2 | Selective seed hunger

Tajikistan's cotton seed market was isolated for most of the two decades following the breakdown of the Soviet Union in 1991. In fact, the import of cotton seed was banned from 1995 to 2008 (Muminjanov et al., 2008; interview 5 May, 2021). This stands in marked contrast to other segments of the seed market. As noted above, cotton is Tajikistan's primary agricultural export commodity (Hofman, 2018). Against this background, the cotton seed market

<sup>7</sup>According to a survey undertaken by FAO (2023) in August 2023, 17% of the households in rural Tajikistan were “estimated to face acute food insecurity” (FAO, 2023, p. 39).

<sup>8</sup>State officials and seed specialists consider membership of the International Union for the Protection of New Varieties of Plants (UPOV) essential to strengthen the domestic seed market. In their view, it would signal a stronger legal seed regime, which could attract foreign investors and encourage seed breeders to invest resources. Calls to join UPOV have been ongoing for over 15 years (Husenov et al., 2021; Muminjanov et al., 2008). Nowadays, Tajikistan's seed laws are aligned with UPOV legislation, but there is no stringent enforcement. Tajikistan has been a member of the World Trade Organization (WTO) since 2013.

<sup>9</sup>There are no seed breeding farms or companies engaged in hybrid seed production in Tajikistan; Dahe Zhongzi Ltd was the only enterprise engaged in hybrid (maize, cotton, and wheat) seed production (interviews 3 April 2021; 11 August 2021).



was deemed too important to allow (foreign) corporate actors to enter, and the state has also undermined farmers' control over cotton seed, and farmers' autonomy, more generally.

In response to the pressure from the International Financial Institutions in the early 1990s, the Tajik state transformed the state planned cotton economy into a private planned economy (Hofman, 2018; Hofman & Visser, 2021; Van Atta, 2009). In practice, it merely came down to a nominal transfer of mandates and control from the state to a select number of elite-run companies. This institutional layout became known as the “futures system.” It enabled the state to appease donors' wishes, while retaining control. The elite-run companies, called “futures companies,” were backed by the state and enjoyed monopsony power in cotton producing areas. They had the prerogative to serve cotton producing farms, which included credit, technology, agrochemicals, seeds, and advice (Boboyorov, 2013; Hofman, 2018). This was, to a large extent, thanks to foreign cotton merchants who prefinanced the futures companies (see also Hofman, 2018). Coinciding with the establishment of the futures system, as a very effective means of power, the state prohibited the import of cotton seeds in 1995 (on the decree prohibiting the import of cotton seed, see Muminjanov et al., 2008). Cotton producing farms had no alternative but to obtain seed from the futures companies.

The cotton seed import ban was lifted with the dismantling of the futures system in 2008 (Hofman, 2018), after coinciding political and economic crises had leveraged the pressure of international donors to demand thorough cotton sector reforms (Hofman, 2018; Hofman & Visser, 2021). The futures system had resulted in spiralling farm debt, which had tied farmers to land (Boboyorov, 2013; Hofman, 2018; Van Atta, 2009). The causes of debt were largely depoliticized, and low seed quality was given as one of the key factors of the decline in cotton production and farm debt. The hope was that the import and spread of foreign cotton varieties, a typical technocratic intervention, would trigger the recovery of cotton yields (interview 5 May 2021; see also Government of Tajikistan, 2007). However, obtaining quality seed has remained problematic. While it is difficult to assess whether a farmer plants cotton out of choice or merely out of force,<sup>10</sup> many lowland farmers are required to plant cotton, and monitoring is strict. However, farmers are left to their own devices to secure inputs, including seeds.<sup>11</sup>

#### 4.2.3 | Seed governance and the social context of seed adoption

Despite the lifting of the import ban in 2008, the import of foreign cotton seed has remained limited. It concerns less than 5% of the amount sown annually,<sup>12</sup> and the cotton seed market could be characterized as being a relatively closed circuit.<sup>13</sup> In contrast to various other cotton economies, for example, Burkina Faso (Dowd-Urbe, 2014; Luna, 2020), South Africa (Schnurr, 2012), and Colombia (Silva Garzón & Gutiérrez Escobar, 2020), there are no transnational agribusinesses directly involved in Tajikistan's cotton economy, which may be due to the lack of centralized coordination of the sector.<sup>14</sup> Whilst the Tajik state still disseminates production plans, there is no control over agricultural supply chains, including the circulation of seed varieties.

However, the lack of control over seed circulation does not imply that farmers can easily reuse or reproduce cotton seed. Farmers depend on ginneries to prepare cotton seed for sowing, because they do not have machinery that can separate seed from the fibre. Yet, most ginneries do not merely act as service providers in Tajikistan: the majority of

<sup>10</sup>There are “numerous structural constraints and cultural pressures shaping and constraining [Tajik] farmers' choices at multiple levels” (cf. Luna, 2020, p. 591, who wrote about farmers in Burkina Faso). Notably, in much of lowland Tajikistan, the agricultural input markets and infrastructure required for the production and marketing of food crops has historically (since the Soviet era) received little attention from the state (see also Hofman, 2021c). Some farmers prefer to plant cotton because it is less perishable than other crops, and market outlets are guaranteed.

<sup>11</sup>Seeds traded in the domestic economy are predominantly linted or “fuzzy” seed. Most imported cotton seed is delinted. Most farmers do not have the required seed planters to sow delinted seed, and ginneries lack the technology to delint seed.

<sup>12</sup>According to ITC data (<https://www.trademap.org/Index.aspx>), the Tajik government reported an amount of 209 tonnes of imported cotton seed for planting in 2022 (see also Figure 1). Sowing rates differ, depending on the type of seed (up to 30 kg/ha of delinted seed and up to 100–120 kg/ha of linted seed). With cotton planted on a surface of circa 185,000 ha, the volume of seed imported in 2022 contributed to less than 5% of planted seed.

<sup>13</sup>I focus on the conventional cotton sector, as the seed supply chains for farmers engaged in organic cotton and the Better Cotton Initiative (BCI) differ; cooperatives and companies engaged in these initiatives regularly offer high quality, imported seed.

<sup>14</sup>As Dowd-Urbe (2014, p. 163) explained in his study focussed on Bt cotton in Burkina Faso: “the persistence of a vertically integrated and state-controlled cotton sector was a key selling point for Monsanto officials when they approached Burkina Faso in 2003 regarding Bt cotton adoption.”

farmers sell their seed cotton (raw cotton) to the ginnery, which (thus) includes seed that could be sown the next season. Ginneries sell the seed that is separated during the ginning process: a limited volume is isolated (sometimes upon a farmer's request) and sold as seed for sowing; the remaining part of seed is sold to oil processing factories. There are few options to prepare seed and gin cotton outside of the ginneries.<sup>15</sup> More importantly, there are governance issues that dissuade farmers to exploring alternatives. The formally registered, elite-owned ginneries are the only actors authorized to issue formal documents attesting to the production and the delivery of cotton in Tajikistan (Hofman, 2021c).<sup>16</sup> In this way, the state controls the production and secures the steady supply of cotton to ginneries.

Thus, farmers depend on external actors for open pollinated cotton seed. Whereas many farmers buy back seed from their ginnery, not all do so. Foreign companies are a second outlet for farmers to obtain cotton seed: a few (often large, capitalized) farmers, as well as a small number of ginneries, traders, and cooperatives, import foreign varieties, mostly from Turkey, Uzbekistan, and China (interviews 29 December, 2022; 23 October 2023). This seed subsequently enters the domestic market. Yet the quantities imported are relatively small (see also Figure 1. Third, and lastly, seed breeding farms (*khojagii tuhmiparvari*) sell cotton seed. There are 60 (out of a total of 90) seed breeding farms specialized in cotton seed breeding.<sup>17</sup> The existence of these seed breeding farms is indicative of the continued role of the state in the rural economy. The Ministry of Agriculture<sup>18</sup> does not have any enforcement power over seed breeding farms, but the farms have a protected status and can only be dismantled by presidential decree. Most, if not all, of these farms are successors of the large-scale Soviet farms. While they are privately run nowadays, they are part of the state-controlled seed system and are often involved in state- or donor-led seed distribution programmes (see, for instance, FAO, 2021): the farms are mandated to multiply and sell certified seed.

However, interviews with farmers and specialists, and World Bank reports (2021a, 2021b) suggest that a substantial percentage of the seed breeding farms operate below standard. In earlier years, there were “over 30 specialized seed farms producing cotton seed, but none [was] able to produce seed that [met] international standards” (Program for Development of the Seed Sector in the Republic of Tajikistan for 2010–2014, quoted in World Bank, 2021a, p. 57). Various farmers complained that the seed distributed by donors and the state remains confined to elite networks and explained that access to seed depends on farmers' social and financial capital. In a conversation on this subject, an employee of an agricultural cooperative, who had spent nine years in China, concluded with a smile: “It's like guanxi!” (18 August 2023). Farmers also experience difficulties to follow up on scientists' and officials' advice to plant specific domestic cultivars, because these seeds are hard to come by (interviews 5 and 26 October 2020).

Most farmers rely on seed from ginneries for financial reasons. Some farmers produce cotton under contract with a ginnery to overcome liquidity constraints. The ginnery provides access to seed (and other inputs) on credit at the start of the season. More generally, the seed sold by ginneries is relatively cheap. However, there are concerns with the seed provided by ginneries. For one, the quality of seed offered by ginneries is reportedly low due to randomly selected seed. Second, there is a lack of clarity regarding the generation of seed: it might be second, third, or even fifth generation seed. Third, farmers lament that ginneries do not offer homogeneous varieties as seed gets mixed up in ginneries. A heterogeneous mix complicates the timing of cultivation practices,<sup>19</sup> and non-simultaneously ripening strains can harm a farmer's public image. A field that looks good is “public proof” of loyalty

<sup>15</sup>In recent years, some actors in Tajikistan's southwestern Khatlon region have started to import mini-ginneries, notably from China (see also, Hofman, 2021a). These ginneries enable farmers to process cotton and clean seed independently. As a result, farmers can subvert ginneries' monopsony power. The mini ginneries offer slightly better prices for seed cotton than formal ginneries offer. This is a very recent development that deserves more attention on its own.

<sup>16</sup>Instead of producing cotton and/or selling cotton to formal ginneries, farmers sometimes pay bribes or purchase surplus cotton harvest from other farmers to obtain the document (see also Hofman, 2021c). Importantly, the state stringently monitors the transport of cotton during the harvesting season, with state officials stationed at ginneries in some districts.

<sup>17</sup>Governmental resolution of 29 December 2018, No. 611. The list accompanying the resolution shows the seed breeding farms' specialization. The majority of these farms are focussed on cotton and cereals. Thus, the specific focus of the seed breeding farms is indicative of the state's priorities, and of the relative role of the state versus corporate actors (and OPVs versus hybrids) in various segments of the seed market in Tajikistan.

<sup>18</sup>The Ministry's seed breeding department coordinates the sector, which includes various agencies and actors. Some of the seed breeding farms simply function as large land holdings in the hands of elites, as I noticed in the field. They use land for commercial purposes instead of investing in seed breeding.

<sup>19</sup>In this regard, there is a marked contrast with Colombian cotton farmers who mix seeds to resist corporate control (Silva Garzón & Gutiérrez Escobar, 2020).

to the state and of agricultural knowledge (cf. Flachs, 2019, p. 49). Several farmers I met in fieldwork complained about seed, as one stated: “Cotton seeds are not clean any longer, they are of low quality (*bezeb*, lit. ugly). The yields are low. Around 22 centnr per hectare [2.2 ton/ha.]. Before [yields] were high, about 40 centnr per hectare” (interview 7 September 2020).<sup>20</sup> In order to secure a satisfactory yield farmers tend to sow large quantities of seed, according to some sources up to 120 kg per hectare (interviews 31 March 2021; FAO, 2021). Once seed germinates, farmers remove a substantial number of plants (thinning) to limit plant density, which implies that only about 30% to 50% of the seed sown matures after germination (interview 31 March 2021). Thus, losses are considerable. Farmers differ in their opinion regarding the origins of the problem of seed: to some it is a conundrum, but the end of the futures system definitely plays a role. From then onwards diverse varieties spread and mixed across localities. A few farmers I met during fieldwork expressed that they perceived the problem of obtaining quality seed to be a deliberate strategy of the state and elites to maintain dependencies (interview 5 October 2020).<sup>21</sup>

In this context, with farmers struggling to obtain affordable, quality seed (see also Abdullo, 2014), and the state looking for foreign investment in the cotton sector, the Gu brothers' interest in investing in the seed sector appeared welcome. As noted, Dahe Zhongzi Ltd became the first (and, until the early 2020s the only) *foreign* venture orientated towards commercial seed breeding with a physical presence in Tajikistan. In the following sections, I go down to the countryside: what ambitions and intentions did the Gu brothers have? How and to what extent did their seed spread and take root?

## 5 | OPERATING AT THE FRONTIER

### 5.1 | Navigating the countryside

After registering the joint venture in 2011, the Gu brothers enjoyed remarkable support from Tajik authorities to develop their company. Through the ties the brothers built with regional and national level Tajik state officials, they were able to secure access to land and to build a seed processing base, as well as a large cotton ginnery. These connections were also indispensable for recruiting a few former state officials and agricultural specialists (interviews 3 December 2020; 26 April 2021). These specialists had worked their entire careers, in various capacities, in Tajikistan's agricultural sector and were experts in navigating the bureaucracy. For some years, Dahe Zhongzi Ltd also rented office space in the building of the Ministry of Agriculture in central Dushanbe, Tajikistan's capital city, which facilitated the building of a network and seed marketing. The company regularly received attention in Tajik media as well. For various farmers, as well as state officials, Dahe Zhongzi Ltd's activities meant, above all, their very first encounter with China's growing influence in the Tajik countryside. Yet there was little known about the Gu brothers' plans. Dahe Zhongzi Ltd's activities in the rural economy initially manifested in vast fields planted with maize, wheat, rice, and cotton in two districts in the Khatlon region, as I witnessed myself in 2012 and 2013. According to Mr. Gu (interview 30 October 2023), the company mainly focussed on the testing of seed varieties and the training of staff in its first years:

*We carried out hybrid cotton seed production in Tajikistan in 2012 and 2013. ... We started pollinating at 5 [o'clock] every morning. We taught a group of local people ... how to pollinate.*

*The old cotton varieties in Tajikistan have a ripening period of 135-140 days, and the fibre content is only 36%. The new varieties I [planted] have a [ripening] period of 125-130 days, and the fibre content is 42-43%. [The hybrid cotton we planted had] 150 bolls per plant and a boll weight of 5.5 grams.*

<sup>20</sup>In Tajikistan, the measurement unit centnr, introduced in the Soviet-era, is still widely used. One centnr equals one metric tonne.

<sup>21</sup>One farmer (interview 5 October 2020) explicitly linked low quality seed to tenure insecurity, relaying that low yields could result in dispossession of farmers. As noted before, land is state owned. Farmers can obtain inheritable land use rights, but “irrational” use of land and leaving land idle for more than two consecutive years, can be a reason to revoke land use rights, as stated in the country's Land Code.

The Gu brothers' aim was to introduce hybrid cotton varieties that, as Mr Gu said (interview 30 October 2023), outperformed varieties grown in Tajikistan. By doing so, Dahe Zhongzi Ltd would cater to the needs of farmers, cotton ginneries, cotton traders, and, as a result, the Tajik state. For farmers, homogeneity of seed and agronomic traits such as yield and ripening period matter most; for ginneries and traders, it is fibre content; for the state, cumulative revenues matter (e.g., export volume and taxes). In the following sections, I examine: how and to what extent did seeds proliferate?

## 5.2 | Technological issues and trusted networks

In 2014, the first two open pollinated cotton varieties under the name of Mr. Gu entered Tajikistan's registry of protected varieties approved for sales (Ministry of Agriculture, 2021), and, as I will describe, many more followed in later years. According to Tajik law, imported seeds have to pass phytosanitary controls and approval by the state's Food Safety Committee (officially, the FSC under the Government of the Republic of Tajikistan). OPVs should be tested for three years in multiple locations, before they can enter into the registry as a protected variety that is approved for sales. This is undertaken by the State Commission for the Testing and Protection of Agricultural Crop Varieties. After that, seeds destined for sales have to be certified yearly by the Food Safety Committee. Hybrid varieties have to be tested for one season to enter the registry on protected varieties. However, not all farmers pay attention to certificates and there is no stringent control on the circulation or reproduction of protected varieties (interview 4 November 2020; see also Husenov et al., 2021).

In order to increase the adoption of seed, Dahe Zhongzi Ltd set up contract farming schemes with farmers in a few lowland districts in 2014 (interviews 24 December 2014; 19 September 2020; 25 October 2020). The contract farming schemes were confined to a few municipalities (*jamoats*), but Dahe Zhongzi Ltd also sold seed outside of these localities. The contract farming arrangements were brokered by Tajik district and municipal authorities, signalling the importance of local institutions and actors in the spread of seed. Yet the contract farming schemes only ran for a brief period, according to company staff because they appeared unsuccessful. Farmers were unable to achieve satisfactory yields, resulting in farm debts. Company staff blamed farmers for using agricultural inputs (provided on credit) for other crops and selling the inputs to other farmers, but they also shared that there had been technical issues. One issue, which also affected overall seed sales, concerned the fact that Dahe Zhongzi Ltd had supplied farmers with delinted seed. As mentioned before (footnote 11), linted seed dominates in Tajikistan's cotton seed market, and most farmers lack the seed planters required for the sowing of delinted seed (interview 14 December 2020). To overcome this problem, the company distributed seed planters in a number of localities. Another technical issue related to crop spacing. Mr. Gu explained that “the [crop] density [of hybrid cotton plants] cannot be [very] high .... In China, cotton is distributed in single rows, and the row spacing is 150 cm. In Tajikistan, the row spacing is 90 cm, because [of] the maximum width of [farmers' plant] seeders” (interview 30 October 2023). Some Tajik farmers raised the issues of crop spacing and crop density as well, but with regard to OPVs. They explained that the Chinese companies applied a sowing width of 75 cm for OPVs, resulting in a relatively high crop density (instead of low); much higher than the crop density of cotton usually seen in Tajikistan. The difference is, as Mr. Gu also noted, related to the machinery used. Tajik farmers' machinery is standardized for sowing widths of 60 cm or 90 cm. I observed that some farmers hesitated to adopt Chinese cotton varieties due to the inability to switch to Chinese sowing practices. These farmers experienced “path dependency,” that is, they were locked-in by technology. As Stone and Flachs (2018, p. 1282) stated: “[s]eed spacing may seem an obscure technical detail in farming, but it has often been a pivotal feature in manipulations of agriculture by external parties.”

In addition to these technical factors affecting the adoption of Chinese seed, some farmers hesitated to plant Chinese cultivars because of the seeds' relatively high fibre content, and, relatedly, a relatively low oil content. Tajik farmers are paid based on the weight of their cotton harvest. Ginneries check for debris, but there is little attention to quality, such as cotton fibre length or strength. Thus, farmers prefer cotton with a relatively high oil content, that is, “heavy” cotton. However, a high yield can compensate for the weight difference, as a farmer remarked: “Yes, [Chinese cotton] is incredibly light. But the yield is really high” (interview 17 September 2020).

In Tajikistan's primary agricultural region, Khatlon, the adoption of Chinese cotton was insignificant in Dahe Zhongzi Ltd's first years. In a survey undertaken by IWMI/USAID in 2016 (Buisson et al., 2016), which included 1100 cotton-growing farmers in various lowland districts (mainly in the southwestern Khatlon region), less than 2% of the interviewed cotton-growing farmers had reportedly sown Chinese cotton seed.

At the end of 2015, Dahe Zhongzi Ltd stopped the contract farming schemes. The company adjusted its approach. In addition to selling delinted seed, it started selling linted seed, and it made a few other major changes. First, it switched from contract farming to networked sales by setting up a distribution network with dealers (*dilerho*). This strategy was initiated by one of the company's employees, who could deploy his connections with multiple actors across the rural economy to recruit dealers. Most dealers were actors of authority, such as local neighbourhood (*mahalla*) leaders, senior agronomists, and employees of the state's district-level agricultural bureaus. As trusted actors, the dealers could help to overcome any hesitation among farmers to purchase Chinese seed. Some dealers took on roles as agricultural extension agents: the few dealers I met during fieldwork had visited Dahe Zhongzi Ltd's seed processing base for information sessions (interviews 20 August 2020; 24 August 2020). The dealers received a seasonally fixed salary and were offered premiums when they attained higher sales volumes, which enticed dealers to actively advertise the seed. Second, Dahe Zhongzi Ltd started advertising seeds on national television, as I saw myself in 2019. The advertisements on television included contact details of individuals who could link farmers to dealers in their vicinity. As a result, the advertisements worked in tandem with the network of dealers to expand the company's reach. Third, Dahe Zhongzi Ltd became involved in the Ministry of Agriculture's 2016–2020 seed sector development programme, with which the company appeared as a formal partner of the state in improving Tajikistan's the seed sector. Notably, Dahe Zhongzi Ltd was the only foreign company involved; the other foreign actors were nongovernmental organizations (NGOs) and donor organizations.

By diversifying the strategy, the company furthered its influence. With the networked sales, it adapted to the social context in which farming is embedded in Tajikistan. Many farmers regularly change seed varieties, but they do not do this randomly. As I observed in the field, they look to their kin, neighbouring farmers, and acquainted senior agronomists for advice on seed and sowing practices (see also World Bank, 2021a, 2021b). Developments in agriculture in Tajikistan are, as Flachs (2019) observed in India, “socially mediated.” Social learning (cf. Glover et al., 2020) plays an important role in seed selection practices. In the survey I carried out in February 2021, over 75% of the cotton-growing farmers reportedly consulted acquainted agronomists about seed issues, and 18% asked advice from other farmers.

While the importance of social learning in farming is not unique to Tajikistan (see, for instance, Flachs, 2019; Glover et al., 2020), there are a few factors that make Tajik farmers particularly susceptible to advice from trusted actors or persuasion by media. For one, the futures system that existed until 2008, described in the previous chapter, restricted farmers' ability to gain experiential knowledge of cotton varieties. Farm fragmentation that took off in the 1990s (Hofman & Visser, 2021) also plays an important role: a substantial number of today's cotton farmers are relatively new to producing cotton individually, and they lack experience in selecting cotton varieties. That is, in earlier years, there were few opportunities for environmental learning (Glover et al., 2020, p. 2).<sup>22</sup> Lastly, while varieties offered by ginneries do not change on a yearly basis, varieties on offer on the domestic market fluctuate, complicating farmers' seed choices. Thus, Dahe Zhongzi Ltd's strategy to turn to a network of dealers, composed of Tajik figures of authority, matched the social context. Tajik individuals also took on an important role when things turned awry.

### 5.3 | Seed struggles

Indeed, Tajik individuals also stepped in to solve problems, for instance, in 2016, when a farmer in an eastern lowland area of Tajikistan sued Dahe Zhongzi Ltd.<sup>23</sup> According to a journalist reporting on the case, the farmer argued that

<sup>22</sup>This is different for food crops, as many rural households have intensively planted food crops on their household plots.

<sup>23</sup>This short section is based on conversations with company staff, state officials, agronomists, and reports in the Tajik media. I was not able to contact the farmer himself.

the yields had been very low and reasoned that the seed certificates were false. The journalist held that the company had imported and sold seed which is normally used for the production of cotton oil. The case took months. The farmer claimed an amount of one million Tajik somoni (in that year about 225,000 US dollars) for incurred losses, but Dahe Zhongzi Ltd eventually won the case. One issue was that there was no evidence: the farmer had submitted the complaint only after the harvest and had pointed to the cotton stalks left on the field. Two Tajik actors who had been involved in the case both questioned the farmer's arguments (interview 16 November 2022; 14 August 2021). Court cases like these are few and far between in Tajikistan, and the case had no consequences. What is striking in the development of the case is the invisibility of Chinese actors. One Tajik employee represented Dahe Zhongzi Ltd as the defendant, completely on his own, without any legal training. The Ministry of Agriculture mobilized specialists for a field inspection (a standard procedure when farmers experience serious problems). There were no Chinese staff involved.

In other situations of contestation, Chinese employees were similarly absent. This is illuminated by the case of another farmer who had purchased a Chinese cotton seed variety in 2017. Persuaded by an advertisement on television, he purchased the seeds from the dealer in his vicinity. According to the advertisement, it was a high yielding, fast-ripening (*tezpoz*) variety (interviews 20 February 2020; 19 April 2020; 20 August 2020). The variety would supposedly ripen in 95 days, much shorter than many other varieties. A short ripening time allows farmers to sow relatively late, to avoid the washing out of seed by heavy rains in spring, or to resow after seed sown earlier has washed out, as well as to harvest before the autumn rain or early snow arrives. However, in this case, when the cotton had still not ripened after 148 days, the farmer dialled the number stated in the television advertisement: "I called to the agent and told him that this variety was not a fast ripening one. It is a lie. We argued. 'This is not a fast ripening [variety] (*in tezpoz nest ku*)!' 'It is.' 'It is not!'" (interviews 20 February 2020; 19 April 2020). The farmer did not take further action, and in later conversations, he shared that his experience (except for the relatively long ripening period) with the seed had been good. However, the farmer had another concern: the yield of the next season with replanted seeds (ordered from the ginnery) had turned out very low. This suggests that he had planted hybrid seeds, something he had not been aware of. As mentioned in earlier sections, hybrids are common in the vegetable and maize seed market in Tajikistan, but few farmers have experience with hybrid cotton seed.

In that period, around five years after the establishment of Dahe Zhongzi Ltd, the Gu brothers continued to enjoy substantial support from the Tajik state. According to a former employee, Mr. Gu was called the "ambassador of Tajikistan to China" by Tajikistan's president Emomali Rahmon, as he was successful in attracting other Chinese businesses to Tajikistan (interview 26 April 2021). In this regard, his activities resembled the Chinese diaspora leader's activities in Laos, described by Chen (2021). Support from the Tajik state was amplified in 2017, when Tajikistan's president Emomali Rahmon visited the farm fields of Dahe Zhongzi Ltd and renamed a Chinese cotton variety to *Dusti-1*, meaning "Friendship No. 1." This variety was one of Dahe Zhongzi Ltd's four cotton varieties that entered the state registry in 2017. *Dusti-1* was a hybrid variety, as were two other varieties of the four registered in that year (Ministry of Agriculture, 2021).<sup>24</sup>

I met various farmers who said to have sown *Dusti-1* in 2020, 2021, and 2023, and I observed that some farmers considered it to be a Tajik variety. In the survey I carried out in 2021, 50% of the farmers who had planted a Chinese variety had done so for the first time. Notably, in conversations in 2023, a few farmers said to have replanted *Dusti-1*. The replanting seems peculiar given that hybrids do not produce true to type (cf. Curry, 2023), but, according to a specialist, farmers had only noticed declines in yields after three years (interview 26 October 2023). This suggests that farmers had treated the hybrid variety *Dusti-1* as an OPV, and, in doing so, frustrated the Gu brothers' plans. However, farmers may have planted another Chinese variety, only naming it *Dusti-1*. Unfortunately, I have not been able to verify whether it really concerned the hybrid variety. That said, there were various factors that impeded the brothers' business. I turn to political issues next.

<sup>24</sup>I do not know to what extent all seeds were produced by Dahe Zhongzi in Tajikistan, or (partially) imported from China.

## 5.4 | Barriers to breed, and hindrances to hybridization

In addition to the technical, financial, and social issues described above, the Gu brothers' plans met with political contestation. As an official stated, with reference to the Gu brothers:

*In China all kinds of hybrids (gibrid) exist, but open pollinated varieties (sort) are better. [...] Hybrids have to be purchased every year. Every year. Our farmers [are not able to do so]. For that purpose, the authorities have said: "bring open pollinated varieties." The varieties can be tested, and if they meet the requirements, the authorities regionally approve (mintaqabob mekunand) them after. Then, the varieties can spread among farmers, [and] farmers can use the seeds for various years.*

(Interview 24 October 2023)

However, while hybrid seed is relatively expensive, farmers also have to buy OPVs on a yearly basis, as explained in section four. Prices of cotton seed vary, depending on quality and type, for example, whether or not seed is imported, and whether seed is linted or delinted. In recent years, locally circulating OPVs have been at least four times cheaper than imported (hybrid) seed. However, because of weight differences, one cannot easily compare prices of delinted and linted seed.<sup>25</sup> The OPVs sold by Dahe Zhongzi Ltd were slightly more expensive than seed offered by ginneries (eight to 12 Tajik somoni/kg, the equivalent of ca. one US dollar in 2020–2021). The price of hybrid varieties sold by Dahe Zhongzi Ltd in 2017 (around 40 Tajik somoni/kg, then the equivalent of ca. 4.5 US dollars), was comparable with the price of foreign imported seed (interview 26 October 2023).<sup>26</sup>

In a conversation, Mr. Gu articulated the challenges and shared his frustration: "In Central Asia, the production and promotion of seeds will not bring much profit [if there are no] hybrid varieties!" (interview 30 October 2023).<sup>27</sup> As explained in section four, there is no centralized control over the seed supply chain in Tajikistan. The Gu brothers could not control the circulation of OPVs, and they hoped to profit from the sales of hybrid seed, which, in principle, has to be purchased anew on a seasonal basis, from the breeder (or seed breeding company).

However, various factors, including specific characteristics of Tajikistan's agrarian political economy impeded the Gu brothers from realizing their plans. They had not anticipated the complexities of the country's seed market, and they left Tajikistan in 2018. Mr. Gu stated (30 October 2023):

*Why has China's agriculture developed so rapidly in recent years? ... the government respects intellectuals and the intellectual property rights of [new variety breeders]. The government actively promotes and publicizes new varieties, and farmers [...] are willing to pay high prices for new varieties. [This is totally different in Tajikistan].*

*Because the demand in Tajikistan is too small, large-scale production and sales are a problem. If we send a few technicians, it will be very expensive. So [we stopped]. However, our work was very successful and the quality of the hybrids produced was very good.*

In making this statement, Gu made explicit his profit-orientated motives, in contrast with the way in which he earlier framed the project, namely as a "cooperation project." What exactly happened remains somewhat unclear in

<sup>25</sup>Delinted seed is much lighter than linted seed. Farmers may sow up to 30 kg of delinted seed, compared with 80 to 120 kg of linted seed (interview 31 March 2021; see also FAO, 2021).

<sup>26</sup>As for vegetables and cereals (e.g., maize), Chinese seeds can be up to ten times cheaper than, for instance, Dutch, German, or Turkish seeds (interview 2 January 2023). The price difference is less pronounced for imported cotton and wheat seed.

<sup>27</sup>Mr. Gu's commercial motives also clearly surfaced when talking about his interest in soybeans in Kazakhstan (the country he went to upon departure from Tajikistan): "But soybean seeds are not hybrids, so it is difficult to control the market" (interview 30 October 2023).



Tajikistan, and it is impossible to know who had the final say, and why. In Tajikistan, people questioned the circulation of the company's money, and the story goes that one of the two brothers fled and left Dahe Zhongzi Ltd indebted to the Tajik state, having embezzled Chinese state funds (interviews 20 August 2020; 3 December 2020; 22 June 2023). The other brother left Tajikistan slightly later, and retained contact with a few Tajik specialists (interviews 14 December 2020; 26 April 2021; 30 October 2023).

After the brothers' departure, the joint venture split and the companies were renamed. According to employees, the SOE from Henan (mentioned in section four) has taken over full control. However, the company's activities have dwindled since then, as has attention from Tajik media and support from the Tajik state. Between 2018 and 2023, five other cotton varieties (all OPVs) developed by Dahe Zhongzi Ltd (or in fact, its successor) entered the registry (Ministry of Agriculture, 2021; interview 11 October 2023). Sales of OPVs have continued, but the dealers are not actively engaged any longer. Due to various factors, the Tajik context did not appear conducive to the Gu brothers' plans.

## 5.5 | Seed travels

Benefitting from, as well as restricted by, contextual factors, Dahe Zhongzi Ltd's seed has gradually spread in Tajikistan since 2014. What do macro-level data show? The trends visualized in Figure 1, based on data provided by the International Trade Centre, show very small volumes of imported Chinese cotton seed. In general, the import of seed is limited, as noted before. However, trade data do not provide insights into (1) *who* is exporting or importing, (2) *what types* of seed is imported, (3) *why*, and (4) *with what result*.

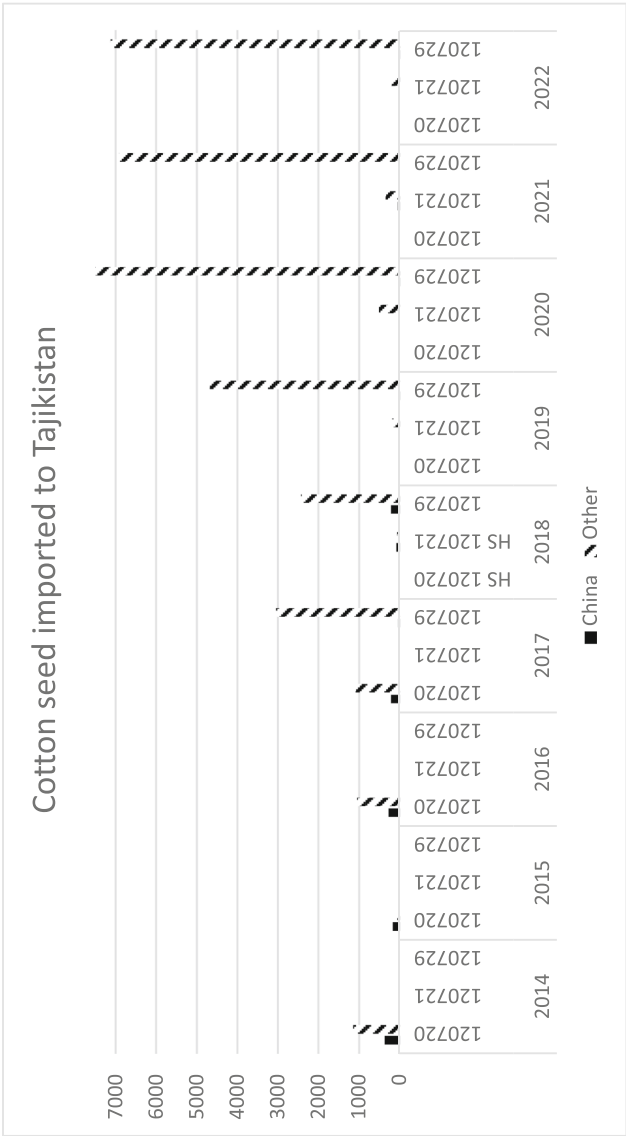
In other words, trade data do not give insights into the ways in which seed, and what types of seed, land in existing seed markets (or whether it is reexported). Dahe Zhongzi Ltd's activities on the ground, and the local circulation of seed more generally, cannot be inferred from the data. Importantly, while imports are limited, there are various actors engaged in the trade of diverse kinds of seed: OPVs and hybrid seed, seed for sowing, and seed used for other purposes.<sup>28</sup> As mentioned in footnote 6, there are two other Chinese agribusinesses engaged in cotton production in Tajikistan as well. They regularly import seed for their own operations. Tajikistan also imports large volumes of cotton seed for the production of cotton oil (the most popular oil in the country) and cotton cake, mostly from other countries (e.g., Kazakhstan). In fact, as Figure 1 shows, the the imported volumes of seed “excluding for sowing” are much larger than the imported volumes of seed “for sowing”. The Tajik state only distinguished cotton seed for sowing (versus other seed) from 2017 onwards. As a result, seed imported before 2017 could refer to any type of seed.

The Tajik state's registry of certified cotton varieties approved for sales included ten Chinese varieties out of a total of 52 medium staple cotton varieties (mostly Tajik ones) in 2021 (Ministry of Agriculture, 2021).<sup>29</sup> Mr. Gu was listed as the breeder of seven of these varieties. Two other varieties introduced by the company were approved for registration in 2022 (interview 11 October 2023). These dynamics point to a significant role played by China in Tajikistan's cotton seed market in terms of registered varieties approved for commercialization: about 20% of all registered varieties (in 2021) were Chinese.

The registry, however, does not say anything about adoption rates. As noted above, according to survey data (Buisson et al., 2016), only a very small number of farmers planted Chinese cotton seed in 2015–2016.

<sup>28</sup>The so-called HS codes (Harmonized Commodity Description and Coding System) for cotton changed in 2012. The single HS code used for cotton seed, HS120720, was split into HS120721, referring to seed for sowing, and HS 120729, referring to seed “excluding for sowing” (e.g., for the production of oil or cotton cake). Tajikistan introduced HS 120729 in 2017 and started using HS 120721 in 2018, as shown in Figure 1. I thank Helena Farrall for clarifying the coding changes. For the years prior to 2017, the types of seed traded under the code HS120720 can be inferred from their value. For instance, according to ITC data, seed imported from Kazakhstan in 2016 was almost three times the weight of seed imported from China, but its total value was 40% lower. Thus, the seed imported from Kazakhstan was much cheaper and presumably concerned seed destined for other purposes (not for sowing).

<sup>29</sup>These all concern medium staple cotton varieties (*Gossypium hirsutum*). The 2021 registry also lists nine long-staple cotton varieties (*Gossypium barbadense*). These were all Tajik varieties (Ministry of Agriculture, 2021).



**FIGURE 1** Cotton seed imported to Tajikistan (imported quantities [tonnes], 2014–2022).  
Source: International Trade Centre (ITC) (<https://www.trademap.org/Index.aspx>). \*Note: codes refer to: HS 120720: cotton seed for sowing/other purposes, HS 120721: cotton seed for sowing, HS 120729: cotton seed excluding for sowing.

Qualitative insights suggest that the diffusion has gradually increased in more recent years, and in a small survey I carried out in February 2021, in the district in which Dahe Zhongzi Ltd (after 2018, its successor) has been operating since 2012, almost 25% of the interviewed farmers reportedly sowed Chinese seed in 2020; 67% of the farmers who reportedly sowed Chinese seed mentioned *Dusti-1*, and the other 33% only referred to “Chinese cotton.”<sup>30</sup> Whereas more representative insights on adoption rates are absent, this growth, as well as the relatively high presence of Chinese seed in the state registry, is noticeable; more noticeable than trade data suggest. As described in earlier sections, diverse actors have been involved in these developments, which remain invisible in macro-level data and address the importance of multiscalar, multisited research. As Green (2022, p. 1250) stated, referring to Chinese projects in Cambodia: “understanding China as an agent of intensified agricultural development [...] is limited if theoretical analysis is confined to food regime relations operating at the global scale.”

What about global imaginaries of China? How and to what extent do global narratives and discourses affect and/or represent perceptions and dynamics on the ground? Do global debates inform farmers' attitude towards Chinese seeds?

## 5.6 | More foreign than foreign seeds?

Globally, as also stated in the introduction of this article, China's footsteps in foreign agrifood markets are followed with suspicion, particularly among actors in the Global North, and the rhetoric of neo-colonialism and neo-imperialism regularly features in discussions on China's growing assertiveness across the globe (for critiques, see Pantucci & Petersen, 2022; Hofman & Ho, 2012; Bräutigam, 2015; Yan & Sautman, 2010).

“Throughout their history, humans have persisted in their efforts to move crops into new niches and places, whether to secure subsistence, expand empire, generate wealth, or support the growth of cities and states, industries and institutions” (Bray et al., 2019, p. 25). As earlier sections illuminated, the Gu brothers aimed for profits; their business activities were enabled by the Chinese state, but driven and shaped by private interests. They did not aim for sowing the seeds of empire.<sup>31</sup>

Relatedly, grand narratives and imaginaries of China and anti-China sentiment in Tajikistan (cf. Hofman, 2021a; Pantucci & Petersen, 2022; van der Kley & Yau, 2021) do not significantly affect farmers' seed selection. Various farmers I met during fieldwork considered the availability of Chinese agricultural inputs as an opportunity, rather than a threat. Dahe Zhongzi Ltd offered relatively affordable, homogeneous seed. Thus, departing from anti-China sentiment throws little light on everyday seed politics. Many farmers struggle to find affordable, reliable seed. Cotton weight, yield, and price have priority. When all else is equal, origin matters.

The spread of Chinese seed also does not explicitly trigger seed sovereignty concerns. In the existing cotton seed market, most farmers already depend on external actors, namely, ginneries, and foreign varieties are widespread. In recent years, farmers have started using mini-ginneries, which allow them to clean seeds and process cotton relatively independently, as noted in section four. These mini-ginneries have spread in response to ginneries' incapacity to supply quality seed and are an expression of farmers' protest against ginneries' monopsony power. The development has not been triggered by the spread of Chinese seed.

This is not to say that there are no concerns or controversies at all (see also Hofman, 2016a, 2016b). Various Tajik scientists condemn the influx of foreign cotton varieties (including, but not only, Chinese cultivars) and regret the drastic decline in state support to agricultural science since the 1990s, and the loss of precious long-staple varieties that were developed and planted in the Soviet era. With regard to Chinese seed, there is one specific concern:

<sup>30</sup>Those respondents did not mention a variety name. Thus, the seed may refer to seed sold by other traders or companies.

<sup>31</sup>The notion of “seeds of empire” has been used by other authors in earlier academic works (see, for instance, Torget, 2015). However, I was not inspired by Torget's book title.

Chinese seed is often thought to be genetically modified. As a scientist relayed: “Here (see), Chinese varieties, [and] Flash, Flora, it’s all GMO! Those are transgenic selections (*Vot Kitaishki sorta ... Flesh, Flora vsjo eto GMO ast! Seleksiya i transgeni ast, ino*)” (interview 21 October 2020).<sup>32</sup> In an interview, a farmer also narrated that an employee of an international donor organization had warned farmers, during seminars held in his community, not to plant Chinese seed, as humanity would become extinct as a consequence. The fourth generation (*nasli chorum*) would not be able to bear any children (interview 10 June 2020). While I cannot triangulate the farmer’s statement, I also observed that various external observers and individuals within the expat community (in Tajikistan) associated Chinese cotton seed with genetic modification.<sup>33</sup> The Chinese presence in Tajikistan’s rural economy has been met with suspicion, and I concur with Lu (2021) as she noted that there is a persistent tendency to “exoticize Chinese capital by playing up its differences from traditional development partners and constructing Chinese investments as a threat to host country sovereignty and the global economic order” (Lu, 2021, p. 425).

The Gu brothers worked with various actors, from the national to the municipal level, and over the years the network of actors expanded and appeared crucial to navigating Tajikistan’s complex bureaucratic and rural landscape. Indeed, Chinese companies’ inroads into foreign agricultural input markets rely on state and private individuals and institutions. Still, whether or not seed takes root is contingent on many factors that cannot all be controlled by skilful brokers. The commercially orientated Gu brothers encountered technical hurdles and cash-strapped farmers, who farmed according to their knowledge. Furthermore, political contestation inhibited the brothers from capitalizing on their skills and efforts. The unfolding of Global China is shaped by actors and environments; Chinese state support may set processes in motion but is no guarantee for success.

## 6 | CONCLUSION

In this article, I analysed the growth of Chinese actors’ activities in Tajikistan’s seed market from the ground up, with a focus on Tajikistan’s cotton economy. I situated this development in the context of China’s growing assertiveness in the global agrifood regime. In doing so, the article sheds light on the ways in which China’s growing role in foreign agrifood markets unfolds, based on multisited, multiscalar analysis.

The growth and intensification of seed trade between China and Tajikistan is the result of bilateral trade ties that intensified with the BRI, and changes in production relations and the agricultural economies in both countries. Given China’s footprint in Tajikistan, an examination of Chinese actors’ engagement in Tajikistan’s politicized cotton economy is apposite to gain insights into the ways in which Chinese actors navigate foreign seed markets. I examined developments over time and place and addressed various factors that challenged the Chinese seed breeders in realizing their plans.

“China is emerging as an important capital exporter, with state-owned agrifood and chemical companies ‘going global’ and making unprecedented capital investments through foreign acquisitions” (Belesky & Lawrence, 2019, p. 1123), but there are various actors and factors constitutive of China’s growing role in food and farming systems. Chinese companies’ acquisitions of transnational agribusinesses are only one way in which Chinese capital has globalized in the last two decades. The case described in this article illustrates the complex nature of Chinese actors’ engagement in foreign agrifood markets. Future research could provide more quantitative insights and examine dynamics and “battlefields” of other kinds of agricultural knowledge, in and beyond Central Asia.

The analysis contributes in three ways to the literature and debates on China’s growing assertiveness in foreign agrifood markets and Global China more generally, and the scholarship on seed politics. For one, the case of the Gu

<sup>32</sup>The varieties “Flash” and “Flora” are Turkish varieties that were imported to Tajikistan in earlier years; they are not Chinese. Thus, the scientist held that not only Chinese cotton but also other foreign varieties were GM cotton.

<sup>33</sup>There is no (publicly available) information about the planting or spread of GM cotton seed in Tajikistan. A foreign lab detected GM cotton in a sample of seed sold in Tajikistan once in earlier years, analysed upon request by a foreign company (interview 15 June 2021). There are no laboratories in Tajikistan to analyse seeds. Mr. Gu stated that he was not interested in GM cotton (interview 30 October 2023).

brothers addresses that China is not a monolith (see also Hofman, 2016b; Lu, 2021). While the Chinese state, directly as well as indirectly, plays an important role in furthering China's role in foreign agricultural markets, including by driving capital over the border (cf. Klinger & Muldavin, 2019; Lu, 2021), it was Chinese individuals who gave shape to the form state capital took in Tajikistan.

Second, while analyses of Global China tend to foreground the Belt and Road Initiative, to explain China's growing global presence, the case of the Gu brothers shows that developments span a longer period of time. Indeed, "China's standards internationalize through the growing market share of Chinese companies, with the Belt and Road Initiative (BRI), a major infrastructure investment initiative, playing a significant role in this" (Rühlig & ten Brink, 2021, p. 1197). However, the BRI follows the Go West and Go Out policy programmes (see Klinger & Muldavin, 2019; Summers, 2016). The Gu brothers initiated their project in Tajikistan in the early 2010s. By couching their plans in terms that spoke to the Chinese state, they could actualize the state's policy plans in ways that matched their private interests. In 2013, they jumped on the bandwagon of the BRI, when the initiative was launched.

Third, the encounters and developments discussed illuminate that Tajik farmers' seed selection practices cannot be understood without attention to the historical and social context of seed adoption, and particularly the political economy of cotton in Tajikistan. As addressed in other studies, seed adoption is a complex practice that involves social, technical, financial, and institutional (political) aspects (Dowd-Urbe, 2014; Schnurr, 2012; Stone & Flachs, 2018). The Gu brothers aimed to profit from the "seed hunger" of Tajik farmers and the Tajik state by introducing hybrid varieties. Along the way, they encountered various hurdles. In response, they adjusted and finetuned approaches to match the social embeddedness of farming in Tajikistan. Intermediaries came to play a crucial role. The essential role of brokers and intermediaries has also been addressed in other studies focussed on Chinese foreign investment (Chen, 2021; Oliveira, 2019). Indeed, the contextual factors that influence seed adoption and the factors that affect the unfolding of Chinese foreign investment partially overlap.

Hence, attention to the local agrarian political economy is crucial to understanding the extent to which seeds are adopted, and whether, and to what extent, Chinese companies and their plans materialize on the ground. As Peine (2021, p. 73) noted in her analysis of the China-Brazil soya trade: "the penetration of Chinese capital into [foreign economies] is as much a social and geographic process as a political and economic one" (see also Loughlin & Grimsditch, 2021).

Anti-China sentiment did not play an important role in farmers' seed selection and the diffusion of seed more generally. These findings resonate with Luna's 2020 observations of Burkinabè farmers' seed adoption practices. Among both Tajik and Burkinabè farmers, contextual factors play more important roles in seed selection than grand politics: politics revolving around Global China in the context of Tajikistan, and global debates about GM crops in the context of Burkina Faso. Luna's (2020) reflection on farmers' attitude towards Bt cotton in Burkina Faso is also relevant to understand and explain attitudes towards Chinese cotton seed in Tajikistan (and, I would argue, beyond): it is imperative to situate Chinese actors' engagement in foreign agrifood markets, and attitudes towards this engagement, in the local context, and the "processes of capitalist transformation already underway" (Luna, 2020, 581). Indeed, it is important to nuance "[conceptualizations] of global food regime transitions ... This is particularly important at a time when conclusions about China's global influence are politically charged" (Green, 2022, p. 1267).

This article has addressed the importance of multiscale and grounded research approaches on Global China, which are essential to understanding the interplay between the push and pull factors at the macro-level that give impetus to China's globalization, and the contextual factors at the micro-level that subsequently shape the manifestations of China's globalization on the ground. As Lu (2021) explained: multiscale approaches are important to "capture individual level decision-making, sub-national power dynamics, and the material consequences and political histories of the types of activities Chinese investors engage in and the landscapes they impact" (Lu, 2021, p. 435, emphasis added). It is important to bring geopolitical rivalries more strongly into the analyses of trajectories of agrarian change to explore whether, how, and to what extent global narratives and macro-level dynamics inform the rural every day, and how trajectories of transformation are negotiated and affected by various actors and factors.

The reality is more complex and nuanced than one might expect. Seed and agricultural knowledge travel, but the way in which they do so is not a given. Seed matters.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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