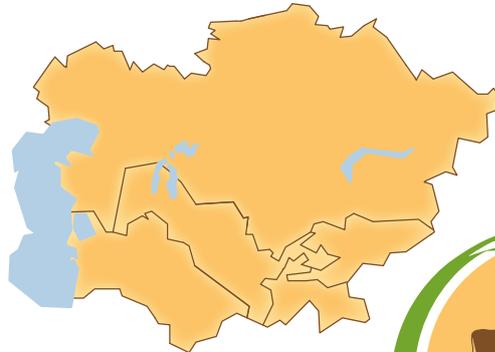


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DISCUSSION  
PAPER  
2020 #193

# Livestock in Central Asia: From rural subsistence to engine of growth?

Sarah Robinson

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## ABSTRACT

This paper presents an overview of the livestock sector in Central Asia using national statistics and field survey data. Growing consumer demand and underused pasture reserves suggest significant potential for growth. But production is fragmented between many small household producers with poor access to land, family farms and very large (but often inefficient) enterprises.

Few producers can supply quality livestock products at high volumes, leading some meat and milk processors to favour imported produce. Peri-urban milk suppliers may participate in value chains through wholesalers, but in remoter areas farms specialise in meat production, reliant on long chains of intermediaries. Only in Kazakhstan do international agreements, slaughter and animal health arrangements favour export prospects in the near future.

Since the 1990s, winter fodder deficits have limited livestock productivity. Domestic fodder production is increasing in Kazakhstan and Kyrgyzstan, but is hindered by state order policies in Turkmenistan and Uzbekistan. Dairy producers close to markets often provide high quality fodder, whilst need for supplements is lower amongst mobile meat producers with winter pasture. Amongst the latter, a class of large commercial operations is emerging, whilst smaller farms lacking access to grazing resources find it harder to grow.

Government policy often magnifies differences between small and large producers, for example through conditions for subsidies or land access procedures. Subsidised credit is available in most republics but uptake is limited by effective demand. Improved public services, better support for service cooperatives and decentralised processing and slaughter facilities would help producers increase value from their livestock.

**KEYWORDS** Central Asia, livestock, marketing, fodder, pasture, policy

## РЕЗЮМЕ

### Животноводство в Центральной Азии: От подсобного хозяйства к двигателю роста?

Данная статья представляет обзор сектора животноводства в Центральной Азии с использованием данных национальной статистики и полевых исследований. Растущий потребительский спрос и недостаточно используемые запасы пастбищ предполагают значительный потенциал для роста. Но производство остается раздробленным между мелкими домашними производителями с плохим доступом к земле, семейными фермерскими хозяйствами и крупными (но часто неэффективными) сельскохозяйственными предприятиями.

Немногих производителей могут поставлять качественную продукцию животноводства в больших объемах. В результате переработчики мяса и молока также предпочитают импортную продукцию. Пригородные производители молока могут участвовать в цепочках добавленной стоимости через оптовых торговцев. В отдаленных районах фермерские хозяйства специализируются на производстве мяса, полагаясь на длинные посреднические цепочки. Только в Казахстане международные соглашения и меры по убою и охране здоровья животных благоприятствуют наращиванию экспорта в ближайшее время.

С 1990-х годов продуктивность скота ограничена дефицитом зимних кормов. Происходит рост внутреннего производства кормов в Казахстане и Кыргызстане. В то же время политика государственной закупки сдерживает наращивание производства кормов в Туркменистане и Узбекистане. Производители молочной продукции, расположенные вблизи продовольственных рынков, часто имеют доступ к высококачественным кормам. В то время доступ к выпасу на зимних пастбищах снижает потребность в кормовых добавках у производителей мяса, среди которых появляется класс крупных коммерческих предприятий. Мелкие фермерские хозяйства, не имеющие доступ к пастбищным ресурсам, испытывают проблемы с расширением производства.

Государственная политика часто увеличивает различия между мелкими и крупными производителями, например, из-за условий предоставления субсидий или процедур доступа к земле. Субсидированный кредит доступен в большинстве стран региона, но его использование ограничено платежеспособным спросом. Совершенствование системы государственных услуг, более эффективная поддержка сервисных кооперативов и предприятий по переработке и убою помогут производителям повысить доходы от животноводства.

#### КЛЮЧЕВЫЕ СЛОВА

Центральная Азия, животноводство, сбыт, корм для скота, пастбище, политика

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## 1 \ Introduction<sup>1</sup>

In this paper we summarise key findings from the ANICANET project *Revitalising animal husbandry in Central Asia: a five-country analysis*, focussing on the contribution of the livestock sector (in particular milk and beef production) to national economies, trends in grazing and feeding patterns, value chain development and government policy. Analysis is based on national statistical data;<sup>2</sup> country reports produced by project partners for the five republics (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan); and fieldwork at case study sites in Kazakhstan Kyrgyzstan and Uzbekistan, using semi-structured interviews and a quantitative survey.

Once a supplier of meat, dairy products and animal fibre to the Soviet Union, the Central Asian livestock sector suffered severe reversals following independence. Economic collapse combined with the breakdown of feed supply chains, long distance grazing management and veterinary systems led to plummeting productivity and, in some republics, loss of a large proportion of the national herd. With the disappearance of inter-republic trading links within the Soviet Union, marketing became a domestic and even local affair.

Yet the livestock sector in Central Asia is often cited as an area with tremendous potential for growth. Increasing urban incomes have stimulated domestic demand for livestock products, and given their extensive rangelands, Kazakhstan and Kyrgyzstan are widely expected to become exporters of meat and dairy products once again. However, since 1990 all five Central Asian countries have struggled to identify suitable development strategies for their livestock sectors. Today, livestock are kept for a various purposes, ranging from subsistence and savings, through small scale income generation, to large commercial operations. Owners have a multitude of different strategies for accessing pastureland, feeding and fattening their animals and accessing markets. The constraints affecting different types of producer and appropriate policies to support them may also thus be many and varied. We describe the different types of farming structures raising livestock in each republic and assess their relative contribution to the sector and access to resources. We ask which types of structure are most likely to support a productive and profitable livestock sector and how these can best be supported by governments.

Fragmentation of production hampers market development, with a large proportion of animals owned by small producers. Value chains are still poorly developed, with many stages and few mechanisms to link all but the largest producers directly to finishing operations, retail outlets, processors or even abattoirs. The need to generate large product volumes by processing

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1 This study was conducted within the project "Revitalising animal husbandry in Central Asia: A five-country analysis (ANICANET)" ([www.iamo.de/anicanet](http://www.iamo.de/anicanet)), funded by the Federal Ministry of Education and Research (BMBF). Input to this report were made by the Centre for Economic Development, Uzbekistan: Yuri Naumov, Igor Pugach; TALAP, Kazakhstan: Janil Bozayeva, Dauren Oshakbayev; National University of Tajikistan: Khodjamahmad Umarov; Tebigy Kuwwat Social Unit Enterprise, Turkmenistan: Stanislav Aganov, Yolbars Kepbanov, Gurbanmyrat Ovezmuradov; University of Central Asia, Kyrgyzstan: Baimat Niiazaliev, Kanat Tilekeyev; and Nozilakhon Mukhamedova (Justus Liebig University Giessen, Germany). Thanks to Zvi Lerman for data presented in Table 2. The author is grateful to Martin Petrick (Justus Liebig University Giessen, Germany), Thomas Herzfeld and Nodir Djanibekov (both IAMO, Germany) for their valuable comments during the preparation of this publication.

2 Much of it collated in a database for ANICANET project and the previous AGRIWANET project, with some statistics obtained directly from national statistical publications and from FAOSTAT online.

industries and for export is also a factor affecting investment decisions in different types of production system, both by farmers and governments. We look at market participation amongst different type of livestock producer and discuss the factors affecting the extent to which they benefit from the value of their produce.

Availability of feed and fodder, the import and subsidisation of which underpinned the sector during the Soviet period, severely limits sector growth today. The contribution of the region's vast semi-arid pastures to animal nutrition is hampered by a range of management and infrastructural issues. Such extensive systems suffer from low feed conversion efficiency, producing high greenhouse gas emissions per unit of product. This issue can be mitigated by optimising pasture management; improving winter feed digestibility and hastening attainment of sales weight by fattening. But such strategies demand higher use of precious irrigable land for feed production, a resource in short supply in Central Asia. There are trade-offs between low feed conversion efficiency of extensive systems and the low land-use efficiency of intensive systems, with their potentially high opportunity costs. We look at current trends in feed availability and the factors affecting the intensification of livestock production amongst different farm types. In particular, we ask how government policy determines pasture access and management.

Governments in all five countries have various strategies for sector development ranging from support to state-owned enterprises to subsidies for private farms and rural credit programmes. We look at which types of livestock producer tend to be recipients of these programmes and the barriers to access and uptake.

## 2 \ Five country comparison using national data

### 2.1 | Collapse and transition

The livestock sectors of Central Asian republics share a common past in the collectivised agricultural system of the USSR. **Figure 1** presents livestock numbers since independence, illustrating the swift collapse in inventories in countries like Kazakhstan and Kyrgyzstan which moved comparatively quickly to a market economy. Where restructuring was partial or slower the collapse was avoided but as we will see, the slow pace of reform has had other negative consequences for development of the sector. Today, livestock numbers are growing in all republics, with cattle as a share of livestock units ranging from 58% in Turkmenistan to 84% in Uzbekistan, and totalling around 60% in Kyrgyzstan and Kazakhstan (using FAOSTAT figures and livestock units as defined in Figure 1).

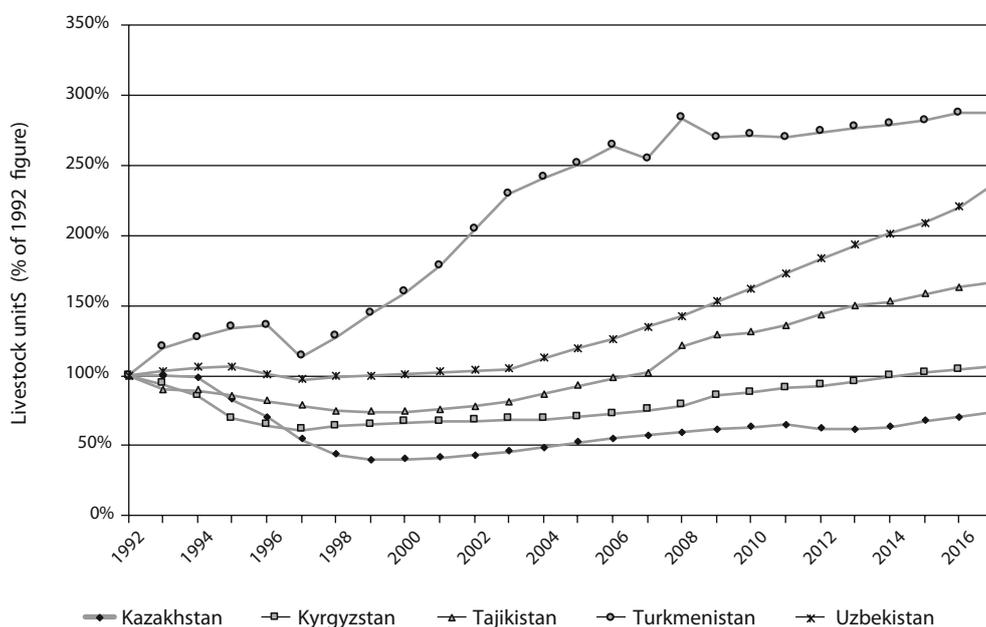


Figure 1 Livestock numbers (as livestock units\*) in Central Asia 1992–2017 as % of 1992 figure

\*Based on [https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Livestock\\_unit\\_\(LSU\)](https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Livestock_unit_(LSU)) - counting all cattle at a value of 1 LU, sheep and goats as 0.1, and horses as 0.8. Camels have been assigned a value of 1.

Source: FAOSTAT.

## 2.2 | Role of agriculture and livestock sector in the national economy

**Contribution to GDP.** The de-industrialisation associated with independence was even more severe than contraction of the agricultural sector, so during the 1990s agriculture rapidly increased in relative importance in national economies. Since then, the contribution of agriculture to GDP has declined considerably, but outside oil-rich Kazakhstan it still accounts for between 10% and 20% of the economy with livestock contributing from 30% to over 50% of total agricultural production value (Table 1; Figure 2). In Kazakhstan, the relative contribution of livestock fluctuates strongly with the grain harvest, which is highly vulnerable to rainfall variability (Broka et al. 2016). Value is dominated by milk and beef (making up 64% of the production value of the sector (Oshakbayev and Bozayeva 2019), whilst in the desert republic of Turkmenistan, despite making up over 50% of inventory in LSU, cattle account for only one third of the total value of livestock sector (Aganov et al. 2019).

**Employment and subsistence.** GDP figures do not fully represent the importance of livestock to the rural economy. A high percentage of Central Asian populations still live in rural areas, many

holding livestock. For poorer households, livestock products may be important in prevention of malnutrition – in Tajikistan 27% of children under the age of five were stunted in 2012, with the equivalent 2006 figure for Uzbekistan estimated at 20% (World Bank 2019). As would be expected from this type of livestock ownership pattern, labour productivity is low, having declined strongly during the 1990s. Since then, improvements have been slow and, with the exception of Uzbekistan, by 2013 output per person had still failed to reach 1980 levels (Gharleghi and Popov 2018).

Table 1 Agriculture and livestock production in the economy

Republic	Agriculture as % of GDP*	Livestock as % agricultural production value (2016)**	Employment in agriculture (% workforce 2017) <sup>†</sup>	Proportion population living in rural areas (%) <sup>††</sup>
Kazakhstan	4 (2017)	38	18	43 (2017)
Kyrgyzstan	13 (2016)	48	27	66 (2017)
Tajikistan	21 (2017)	26	61	74 (2016)
Turkmenistan	15 (2016)	54	43	50 (2016)
Uzbekistan	17 (2017)	37	27	49 (2017)

\* ANICANET Uzbekistan country report (Naumov and Pugach 2019); Statistical Agency of the Republic of Tajikistan (2018c); ANICANET database (Kyrgyzstan, Kazakhstan, Turkmenistan).

\*\* FAOSTAT. Gross Values in international USD (based on constant prices, 2004–2006).

<sup>†</sup> ANICANET country reports with exception of Kazakhstan (OECD 2019) and Turkmenistan (State Committee of Statistics of Turkmenistan 2018).

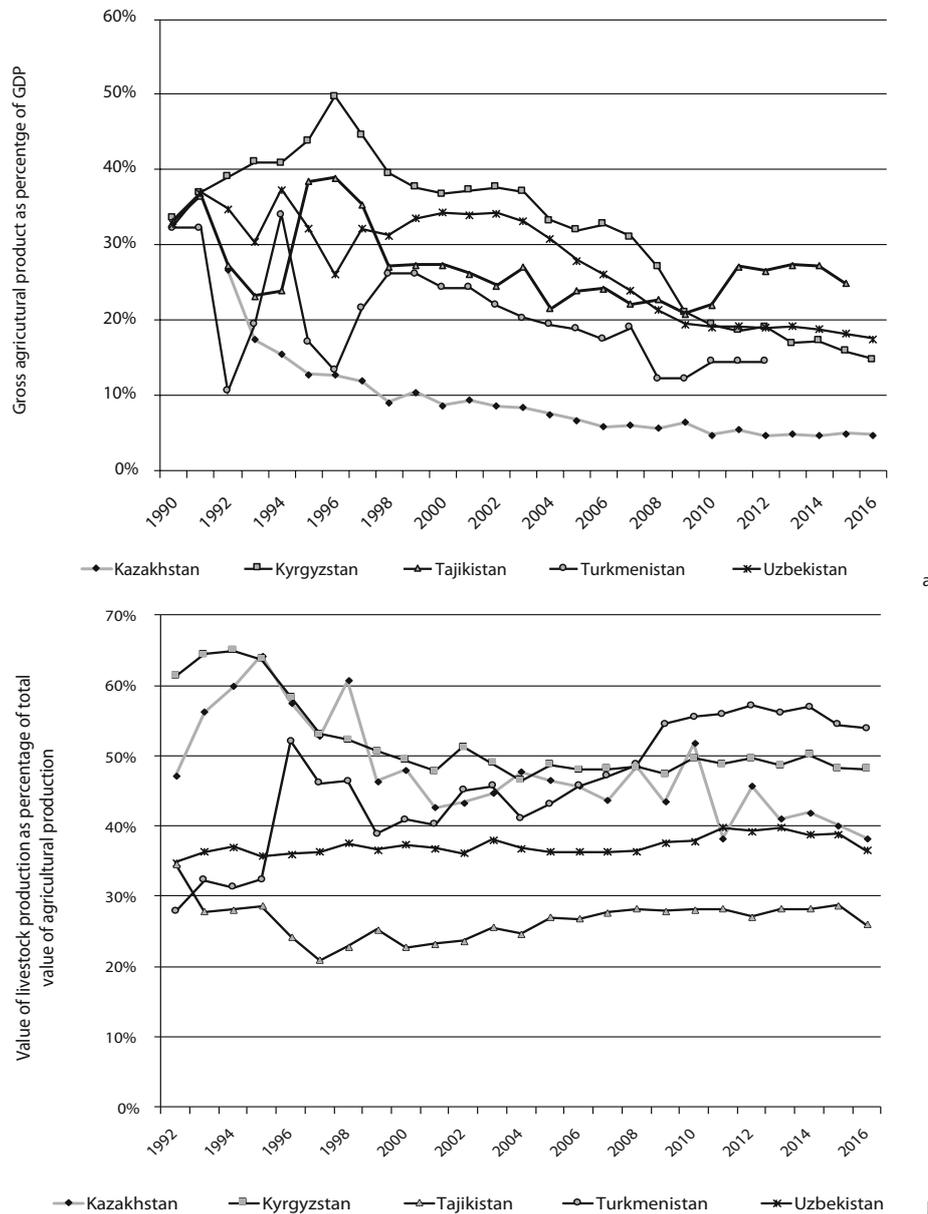
<sup>††</sup> ANICANET database.

## 2.3 | Agricultural reform since independence

**Farm structures.** All five republics share three basic types of agricultural structure – households (HH), family farms (FF) and large enterprises (E). In terms of land, households typically hold only kitchen gardens, although many in Uzbekistan, Tajikistan and Turkmenistan received additional areas through presidential decrees. Enterprises often started out as privatised state farms. Subsequent breakdown of these into family farms occurred at different speeds in each republic and usually involved distribution of land shares to former workers. In Kyrgyzstan this process was automatic and all eligible farm workers received shares. In Kazakhstan and Tajikistan farmers were issued with paper shares to be converted to physical plots through expensive or opaque administrative procedures, resulting in only a partial transfer of land to those eligible. In Uzbekistan there was no wholesale distribution of land to workers; instead individuals desiring land must apply for leaseholds by tender<sup>3</sup> (which is also true of new land acquisitions in Kazakhstan). In most republics beneficiaries of land reform generally accede to the legal status of registered

3 Farmers are allowed to bid in official tenders for tracts of irrigated land that become available for allocation. Applications to district authorities are evaluated by a commission. Households are limited by law to 0.35 hectares of irrigated land and cannot bid in tenders (Naumov and Pugach 2019). The only mechanism by which households may access new land is by applying to district authorities with a request for low-quality unirrigated land (up to two hectares), including an undertaking to improve this land at their own expense (Lerman 2008). This has resulted in a concentration of land amongst a small number of farmers, work on this land as labourers, sharecroppers or sub-leasers (Veldwisch and Spoor 2008, Djanibekov et al. 2013).

‘farmer’. In Uzbekistan these are further subdivided into mixed farms and livestock farms, which must own 30 head of cattle equivalents with at least 0.33 ha of land per head). It was estimated that by 2008 only 10% of rural households had managed to register as farmers and obtain land for lease (Zorya et al. 2019).



**Figure 2** Change since 1992 in (a) Agriculture, value added (% of GDP); (b) Contribution of livestock to gross production value of agriculture (%). Values in international USD (based on constant prices, 2004–2006)

Sources: (a) AGRIWANET, World Bank national accounts data, and OECD National Accounts data files. (b) FAOSTAT.

In Turkmenistan, many collective farms were renamed farmers' associations, which sub-contract arable land or livestock (not pasture) to individual members on a leasehold basis in return for a proportion of output. However, these leaseholders do not have a specific legal status: their private livestock appear in current statistics with households under 'population' whilst the land and stock they lease appear under state enterprises. In addition, a large proportion of pasture is held in 'state livestock farms', managed more directly by the Ministry of Agriculture. A category of family farm known as 'private farmers', do have 'ownership' rights over arable land. But these number only around 3000 and also have not been disaggregated in more recent statistics (State Committee of Statistics of Turkmenistan 2018). Thus the category labelled in [Table 2](#) as 'households' also covers larger family-based farming operations.

The major difference between households and registered farms is one of scale. For example Kazakhstan's 1.6 million rural households have on average two cattle and seven sheep or goats; whilst the mean for its 200,000 family farms is 11 cattle and 34 small stock (ANICANET database). Enterprises are much larger. In Kyrgyzstan, Tajikistan and Uzbekistan enterprises are successor organisations of collective farms and concern state or quasi-state livestock breeding operations accounting for a small proportion of the livestock sector (although in Uzbekistan they still control large areas of grazing land – see [Table 2](#)). In Kazakhstan, large enterprises are run as private companies or agro-holdings, owning a small proportion of national livestock inventories, but a much larger proportion of land and other assets.

**Land tenure arrangements.** In Tajikistan the restructuring programme was based on permanent heritable use, although leasehold is also common. The amended Land Code, approved in 2012, provides for land use rights to be marketable and exchangeable. However, as in much of the region, these rights can be revoked if the authorities deem that land is being misused. In Turkmenistan and Uzbekistan leaseholders of arable land are subject to state plans and thus cannot exercise full decision making over choice of crop. Kyrgyzstan has done furthest in reform, establishing outright ownership of arable land shares early on, allowing development of active leasing markets and, more recently, rights to buy and sell. (Akramov and Omuraliev 2009). In Kazakhstan shares were originally disbursed as 99 year leaseholds. This period was later reduced to 49 years, which applies also to new leaseholds acquired through auction. Whilst Kazakhstan legalised private ownership in 2005<sup>4</sup> this arrangement remains unusual, especially on pastures, due to cost (Alimaev et al. 2015).

The above arrangements applied initially to both arable and pastureland in most republics. However in Kyrgyzstan, following an experiment with leasing, a 2009 law allocated pasture land to municipalities for management through users' associations. In Tajikistan, the 2013 Law on Pastures added an option for 'communal' pasture ownership to existing leasing and permanent use arrangements, implying that pasture could be provided to users' associations established at the village level (Jaborov et al. 2017). In Turkmenistan, pasture is allocated to state enterprises and private users graze stock on this land with no formal tenure arrangements, although a number of new laws seek to change this (see below). Those leasing state herds or flocks cannot market these themselves, but contractual payments in young animals (50% of births) allow leaseholders

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4 When the 2003 land code came into force.

to accumulate their own stock which they are free to manage and market, greatly contributing to growth of the private livestock sector (Aganov et al. 2019, Behnke et al. 2005, Robinson et al. 2018).

**Outcomes of reform: division of assets between farm structures.** Table 2 and Figure 3 compare the distribution of livestock and land between farm structures. In Kyrgyzstan, family farms control 88% of arable land, 63% of cattle and account for 62% of agricultural output (compared to 36% for households and 2% state or collective enterprises). Both family farms and households have access to common pastures managed at the municipal level. By contrast, in Uzbekistan, the proportion of cattle in family farms and enterprises is not only tiny, it is decreasing. Households hold 94% of cattle inventories, yet have no formal access to pasture. Enterprises, with 1% of animals, control 45% of grazing lands. Tajikistan is similar in that households produce 95% of the monetary value of livestock production whilst most pasture is held in farms and enterprises. Moreover, it has been estimated that conversion to rainfed crops has decreased the physical area available by up to 15% (Umarov 2019).

In Kazakhstan, the proportion of livestock and land in family farms is increasing but households still hold around 60% of livestock and have formal access only to common grazing around villages, which constitutes roughly 12% of all pastures. Turkmen farmers' associations hold about 30% of pastures and 90% of irrigated land. Until 2019 an additional 40% of pasture remained directly under government control in state-run livestock farms.<sup>5</sup> Yet 90% of livestock units are privately owned. These include stock belonging to leaseholders or workers in state structures, plus those of residents.

Table 2 Cattle ownership and land access by farm structure

Republic	Cattle ownership (% national inventory)*			Sheep and goat ownership (% national inventory)**			Pasture area legally accessed (% pasture area)**				Arable land legally accessed (% arable area) ††		
	HH	FF	E	HH	FF	E	HH	FF	E	State lands†	HH	FF	E
Kazakhstan	59	32	9	59	37	4	12	23	12	51	1	39	60
Kyrgyzstan	50	49	1	43	56	0	Municipal (42)			54	9	88	4
Tajikistan	93	6	1	82	13	5	0	54	26	20	21	67	12
Turkmenistan	97	-	3	90	0	10	0.1	0	72	26	12	-	88
Uzbekistan	94	5	1	84	8	8	0	7	45	48	13	85	2

HH=Household; FF=Family Farm; E=Enterprise

\*Sources: Uzbekistan (2017): ANICANET database. Kazakhstan & Kyrgyzstan (2017): national statistics (downloadable tables). Tajikistan (2018): Statistical Agency of the Republic of Tajikistan (2018b). Turkmenistan (2017) State Committee of Statistics of Turkmenistan (2018). Turkmen figures for households include both smallholders and larger farms leasing land or livestock from the state, but which lack specific legal status. Land and state livestock leased by these farms are classed under state enterprises, and private livestock with those of households in statistics. Family farms with their own land and livestock exist, but are also aggregated with households in recent statistics.

\*\* Sources: Turkmenistan (2018): State Committee of Statistics of Turkmenistan (2018). Pasture in enterprises comprises 30% in farmers associations; 41% in state livestock farms (currently undergoing privatisation) and 1% in private enterprises such as joint stock companies. Uzbekistan (2017): Naumov and Pugach (2019) citing Narbaev (2018). Kazakhstan (2013): Kazakhstan Statistical Agency (2014). Households may use common pasture owned by rural municipalities, for which areas were obtained from the website of the Committee for Management of Land Resources. Kyrgyzstan (2014): Department for Cadastre and Registration of Immovable Property of the Kyrgyz Republic (2014). Tajikistan (2012): national statistics, provided by Zvi Lerman. Municipal lands and areas leased by pasture users associations (which may include households) exist but are unavailable in statistics.

†Pasture in the state reserve plus pasture managed by the forestry department.

††Sources: Uzbekistan (2017): ANICANET database. Turkmenistan (2018): State Committee of Statistics of Turkmenistan (2018). Many 'households' lease arable land from state enterprises - so these have greater access to land than apparent from figures. Kazakhstan & Kyrgyzstan (2017): national statistics (downloadable tables). Tajikistan (Statistical Agency of the Republic of Tajikistan 2018c).

5 Including 29 sheep farms under the Ministry of Agriculture and eight cattle farms under State Food Industry Association.

The figures presented here represent legal access to land. But actual physical access to grazing land cannot be inferred from statistics. In Turkmenistan (and Uzbekistan to some extent) livestock owners of all types graze on land formally allocated to state enterprises - sometimes with considerable freedom of access (Behnke et al. 2016). In Kazakhstan and Tajikistan landless households or farmers may send animals with relatives having formal access to pastures or sublease pasture privatised by others (Halimova 2012, ANICANET survey data, Kazakhstan). Moreover, Table 2 indicates large areas of unallocated state-owned pasture, which in each republic includes both state reserve lands and land belonging to forestry departments.<sup>6</sup> In all republics, pasture in the latter can be used for grazing under temporary contracts. Much of the state reserve is truly abandoned due to loss of water supply infrastructure, lack of access, or both, but an unknown proportion is certainly grazed. In Tajikistan in particular remaining reserve lands are likely to be used as they constitute essential summer pastures for community grazing.

A further issue in that republic is that the private farming structure coming under our category of 'family farms' also includes forms of privatised collective on which members either work as labourers or farm physical shares but lack full documentation.<sup>7</sup> In reality pasture often remains undivided on such entities and families with few animals rely on collective herding (Robinson et al. 2010). This was the rationale for the introduction of common management in the 2013 law. But once again, statistics do not indicate how much land has been allocated for common use since that legislation was passed. Procedures for pasture allocation are not transparent and it is unclear how district authorities decide whether to allocate pasture to users' associations or private farms (Jaborov et al. 2017). Early reports from donor projects suggest that some users' associations have received land certification, but others sublease from private individuals (Pasture Management Network of Tajikistan 2015, Weperen 2016).

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6 On paper, since 1992 around ten million ha in Uzbekistan was transferred to the land reserve and forest funds (Naumov and Pugach 2019); in Kazakhstan around 75 million ha of pasture were transferred to the state reserve along with significant areas to the forest fund, which now includes eight million ha of pasture (Alimaev et al. 2015). In Kazakhstan the reserve area is now decreasing as pasturelands are leased out to family farms (Robinson et al. 2012), but in 2013 it still included 46% of all pasturelands (Ministry of Agriculture of the Republic of Kazakhstan 2014). The equivalent figure for Uzbekistan was 40% in 2006 (Yusupov et al. 2010).

7 It has been estimated that around one third of the arable land in 'family farms' is held in this kind of collective structure (Lerman 2012, Lerman and Sedik 2008). 2018 statistics break down private farm structures into 'enterprises' and farms (Statistical Agency of the Republic of Tajikistan 2018c). These enterprises are separate from other large operations (which are listed outside the private farm category) and may correspond to collective private farms. According to these figures, 3.5% of arable land and 3.8% of pasture held in private farms belongs to the 'enterprise' variety, down from 5.9% and 6.8% in 2012. Increases in private farm numbers (which have doubled since 2012) may reflect ongoing reform of these structures into true family farms (Statistical Agency of the Republic of Tajikistan 2018c).

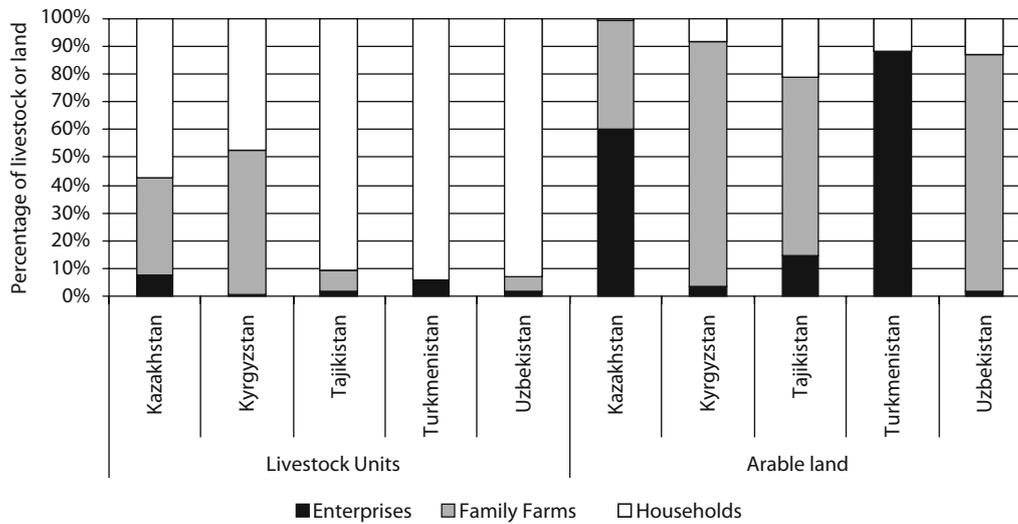


Figure 3 Distribution of livestock units and arable land between farm structures

Sources: Uzbekistan (2017): ANICANET database (horses and camels missing from LU calculation). Kazakhstan & Kyrgyzstan (2017): national statistics (downloadable tables). Tajikistan (2018): Statistical Agency of the Republic of Tajikistan (2018b). Turkmenistan (2018) State Committee of Statistics of Turkmenistan (2018).

**Barriers to entry and government interference.** A question raised by the figures presented is why there are so few family farms and why these control so few assets. The level of ease with which the fruits of restructuring were initially distributed to the population explains a large part of the variation in observed use and ownership patterns. However, today there are also significant barriers to entry and even policies which force people out of farming. Transaction costs of obtaining new land are high in most republics, favouring the wealthiest and best connected farmers. In Uzbekistan and Turkmenistan farmers must fulfil state plans in cotton and wheat, on unfavourable terms. In Uzbekistan even new plans to diversify are state led, whilst forced consolidation (through land seizures from those farmers considered to be ineffective) has greatly reduced numbers of family farms.<sup>8</sup> In Turkmenistan, private farmers were initially given the poorest land and also became subject to expropriation, losing 80% of holdings between 1998 and 2012 (FAO Investment Centre 2012). This sector has only recently started to expand again (Aganov et al. 2019).

8 From 218,645 farms in 2008 to 78,856 in 2014, associated with an increase in average area from 13.9 to 39.5 hectares (Naumov and Pugach 2019). The rationale for this was that many farmers received multiple non-contiguous parcels. Excessive field fragmentation hinders the functioning of irrigation and drainage systems and aggravates the impact of natural disasters. Although the majority of the private farmers asked to return their land were specialised in cotton and grain production, in some cases horticultural and livestock farmers were also asked to give up their land. None received compensation (Djanibekov et al. 2012).

## 2.4 | Animal nutrition

The fodder base of Central Asia is overwhelmingly defined by a surplus of forage (pasture) in summer and deficit of all types of forage, fodder and feed in the winter. The ability to overcome the winter feed bottleneck is perhaps the greatest challenge for sector development in the region.

**Breakdown of grazing systems.** Total pasture areas comprise from 81% (Tajikistan) to 95% (Turkmenistan) of all usable agricultural land in the five republics. Kazakhstan alone has the fifth largest pasture area of any country on earth. Winter pastures (on which vegetation is often free of snow through south-facing exposure or dominance of large shrubby species) are characterised by high winter palatability and feed value and constitute a particularly valuable resource. But outside Turkmenistan such pastures are limited in area and often located far from other seasonal pastures. Migratory systems, formerly benefitting from top-down pasture use planning and the large scale of state farms, broke down during transition and have only partially recovered; many previously grazed desert pastures now lack working water supply for stock, rendering them unusable without large-scale investment. This loss of movement has led to overgrazing on village pastures and other non-remote wintering areas (e.g. Alimaev et al. 2008, Hoppe et al. 2016). In Turkmenistan and Uzbekistan many livestock owners do not even use pastures, grazing their animals all year around in the irrigated zone, between fields, along canals and on stubble after harvest.

**The collapse in fodder production.** Following independence, the total area planted to fodder fell precipitously across the region, reaching a nadir in the 2000s (Figure 4). In market-oriented republics cash crops and crops for human consumption were quickly prioritised by producers, a tendency exacerbated by state plans in Turkmenistan and Uzbekistan - where planted areas have not picked up.<sup>9</sup> In Uzbekistan since 1992, the total number of cattle increased 2.3 times whilst the area under fodder crops decreased by 73%, only partially compensated by yield increases of 3.9 times (Naumov and Pugach 2019). Replacement of fodder by wheat in cotton rotations has caused deterioration in soil fertility (Zorya et al. 2019). The government plans to greatly increase the area under fodder but this will require important trade-offs given that the country has lost 20% in sown area since 1991 due to salinization and erosion (Naumov and Pugach 2019). In Tajikistan, yield increases did not occur and decreases were even observed in some fodder crops (Umarov 2019). Total production broadly reflects the 50% decrease in area sown – with 2016 production of 100 thousand tonnes at half the 1992 level (ANICANET database).

**A partial recovery.** In Kazakhstan, 20.6 million ha of marginal rainfed land was abandoned to 1999 and despite some reclamation, it is unlikely that all of this land will ever come back into production (Petrick et al. 2018). However since 2011 there has been a modest rise in areas planted and larger increase in total production (ANICANET database). Most of the increase is accounted for by family farms which, along with enterprises, dominate production (Table 3, Figure 5). In Kyrgyzstan, the area sown to fodder crops has grown strongly since 2003, increasing by over 20% from 2013 to 2017. In these republics fodder statistics include perennial and annual hays, and maize but

<sup>9</sup> Here the state's control over input supply and high transaction costs for small farmers of obtaining inputs through commodity exchanges also hampers crop production outside state plans (Djanibekov et al. 2012).

exclude other cereals. Maize accounts for 5% of fodder area planted in Kazakhstan, the majority planted by large enterprises (Kazakhstan Statistical Agency 2018). However, from 2013 to 2017 use of other grains for feed production has increased every year, both in absolute terms and as a percentage of total grain utilization (Kazakhstan Statistical Agency 2018).

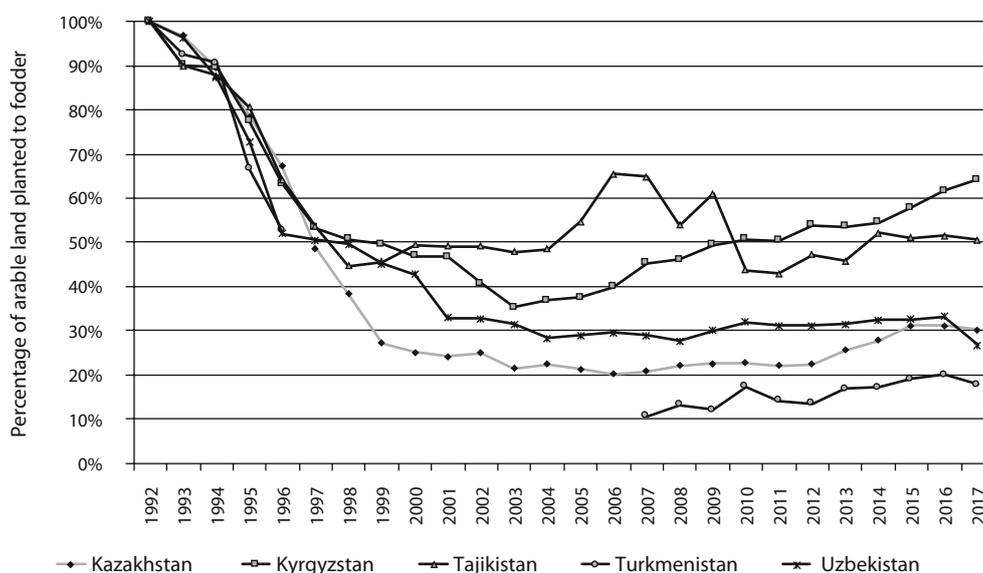


Figure 4 Evolution in area planted to fodder crops – as % of 1992 figure

Sources: Kazakhstan Statistical Agency (2018); National Statistics Committee of the Kyrgyz Republic (2018) and downloadable data tables; Tajikistan: ANICANET database & (Statistical Agency of the Republic of Tajikistan 2018a); Uzbekistan: ANICANET database; Turkmenistan ANICANET database & State Committee of Statistics of Turkmenistan (2018).

Table 3 Structure of fodder production in the five republics (2017)

Republic	% Arable land planted to fodder	LU per ha of fodder planted	Area planted as proportion of 1992 figure	Percentage of total area planted to fodder crops, by farm type		
				HH	FF	E
Kazakhstan	15	3	31	0.5	53	47
Kyrgyzstan	31	7	64	5	92	3
Tajikistan	12	29	51	21	62	17
Turkmenistan	2	114	16	28	-	70
Uzbekistan	4	55	27	16	72	13

HH=Household; FF=; E=Enterprise

Sources: Kazakhstan Statistical Agency (2018); National Statistics Committee of the Kyrgyz Republic (2018) and downloadable data tables; Tajikistan: ANICANET database & (Statistical Agency of the Republic of Tajikistan 2018a), Turkmenistan ANICANET database & State Committee of Statistics of Turkmenistan (2018). All figures for 2017 except breakdown of area by farm type for Tajikistan (2016). Again, for Turkmenistan much of the land under enterprises is leased to individuals and land planted by private farms is aggregated with households.

In both Uzbekistan and Turkmenistan, areas planted to fodder crops are particularly low in relation to livestock numbers (Table 3). But in these countries desert pastures can be grazed in winter and much feed comes from waste agricultural products, such as cotton husks and seed cake. FAO food balance figures suggest strong increases in use of cereals for feed in Tajikistan and Uzbekistan from 2000 to 2013, which may also partially offset the very low areas planted to fodder crops (FAOSTAT). Natural hay lands (unsown) are a crucial resource in all five countries, and are a major source of fodder for farmers lacking arable land. However, poor cutting and storage practises affect both natural and cultivated hay types, greatly reducing their nutritional value (Zhumanova and Maharjan 2012).

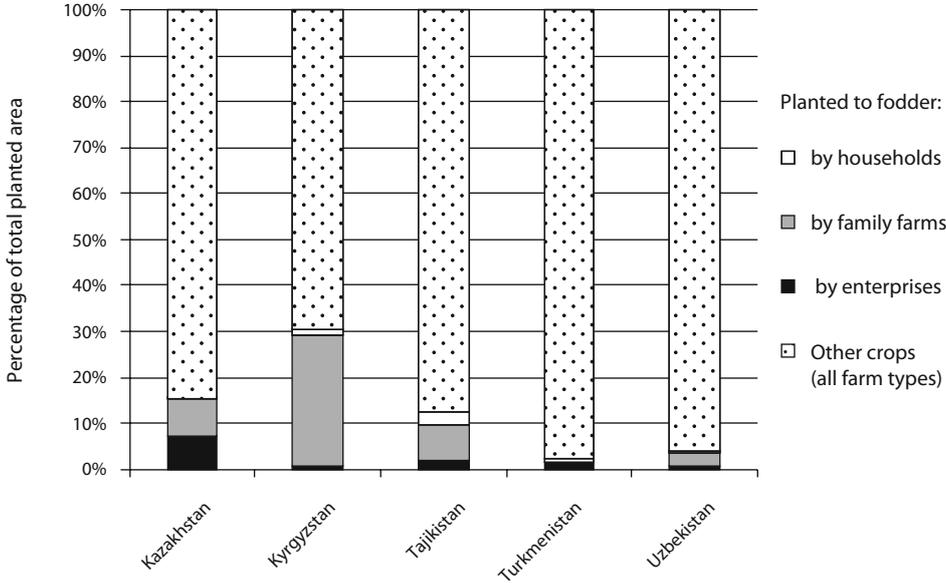


Figure 5 Fodder production as a proportion of total arable land, by farm type (2017)

Sources: Kazakhstan Statistical Agency (2018); National Statistics Committee of the Kyrgyz Republic (2018); State Committee of Statistics of Turkmenistan (2018). Uzbekistan and Tajikistan: ANICANET database. All figures for 2017 except Tajikistan (2016).

## 2.5 | Production outcomes and performance

Reflecting growth in livestock inventories, total production of meat and milk has increased, typically surpassing 1992 levels (Table 4). Exceptions include beef production in Kazakhstan and Kyrgyzstan. However, Central Asia’s population has also grown by almost 50% since 1991. Taking this growth into account, for example in Tajikistan, livestock production per capita exceeds the level achieved in 1991 by a much smaller margin (36% for meat production and 17% for milk). Domestic demand remains unmet, with animal products amounting to 15% of total imports in 2017 (Umarov 2019).

In Turkmenistan enterprises accounted for 1% of milk and 3% of meat production but a much higher proportion of the sector by value<sup>10</sup>, perhaps reflecting investments in processing (Aganov et al. 2019). Although progress towards import substitution of processed products was reported in the press in 2018, statistics suggest increases in imports, at least up to 2017 (State Committee of Statistics of Turkmenistan 2018).<sup>11</sup>

In Uzbekistan, the volume of the dairy products market is estimated at about 2.9 billion USD. The sector is largely dependent on households, which produce 96% of raw milk (Table 6). Around 90% of this is consumed at home, but excess is processed into traditional products such as kaymak, sour cream, chakka, cottage cheese and butter (Naumov and Pugach 2019). The 358 thousand tons of milk going to processing enterprises come almost exclusively from private farms and agricultural enterprises. In contrast to the beef market, in which Uzbekistan is fully self-sufficient, non-traditional dairy products (butter, quality yogurts, cheese) are mostly imported (Naumov and Pugach 2019). Consumption of these products is characterized by rapid growth and Uzbek products are now catching up both in quality and market share. In addition to milk, households also produce the bulk of all other livestock products, accounting for the majority of recent increases in beef production. Farmers produce only 3% of beef, 11% of eggs and 8% of wool.

Table 4 Livestock productivity indicators

	Change in total milk production		Mean yield in 2017 kg/cow/year	Change in total beef production	
	2017 as % of 1992 figure	2017 as % of 2005 figure		2017 as % of 1992 figure	2017 as % of 2005 figure
Kazakhstan	105	116	2337	71	143
Kyrgyzstan	159	133	1974	96	153
Tajikistan	204	201	820	166	182
Turkmenistan	394	99	1764	289	113
Uzbekistan	285	226	2003	232	198

Sources: FAOSTAT.

<sup>10</sup> Around 22% of value of the livestock sector in 2017 was produced in enterprises, double the figure of 2007 (State Committee of Statistics of Turkmenistan 2018).

<sup>11</sup> From 28 million USD in value in 2007 to 159 million USD in 2017 - increasing also as a proportion of total import value from 0.64% to 1.6%.

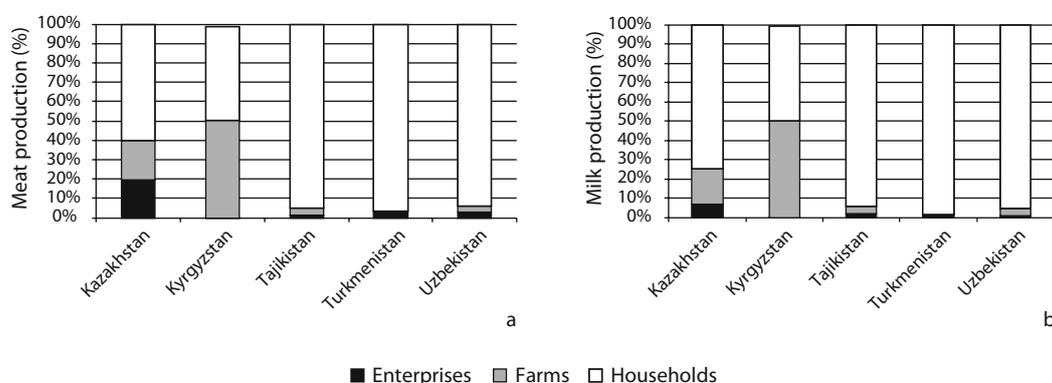


Figure 6 (a) Beef production by farm type 2017; (b) Milk production by farm type 2017

Sources: Uzbekistan: ANICANET database; Tajikistan Statistical Agency of the Republic of Tajikistan (2018b); Kazakhstan Statistical Agency (2018); State Committee of Statistics of Turkmenistan (2018) Kyrgyzstan: National Statistics Committee of the Kyrgyz Republic (2018) and downloadable data tables.

Beef production in Kazakhstan is increasing and already covers domestic demand (Oshakbayev and Bozayeva 2019). Mutton and horse meat are growing even faster and milk production has now surpassed 1991 levels. Family farms are now starting to account for most production increases (Figure 6); from 2006 to 2016 the share of households in meat production dropped from 82% to 60% and in milk production from 91% to 77%.<sup>12</sup> Despite progress, Kazakhstan still imports 25 percent of dairy products, mostly in the form of milk powder (Oshakbayev and Bozayeva 2019), plus many processed meat and animal fat products. Agricultural products make up five percent of all exports, but these are almost exclusively cereals; meat exports are low (OECD 2019, Oshakbayev and Bozayeva 2019). But there are indications of recent growth: although still dwarfed by imports, total export value of all meat and meat products grew strongly in 2018 and 2019; beef exports quadrupled from 2017 to 2018 and doubled again in 2019 (Kazakhstan State Statistical Agency online data).

In this paper we focus on milk and meat production, but it should not be forgotten that Central Asia is also a source of animal fibres, which are less affected by the sanitary rules affecting other products. Chinese cashmere value chains now reach deep into rural Central Asia (Waldron et al. 2014). Following price collapses in the 1990s, Kazakhstan now exports fine and semi-fine wool to China and Russia (FAO Investment Centre 2010a).

<sup>12</sup> Livestock development and policy in Kazakhstan. in Revitalising animal husbandry in Central Asia: a five-country analysis (ANICANET) Kick-Off Workshop, 22 September 2017, Halle (Oshakbayev 2017).

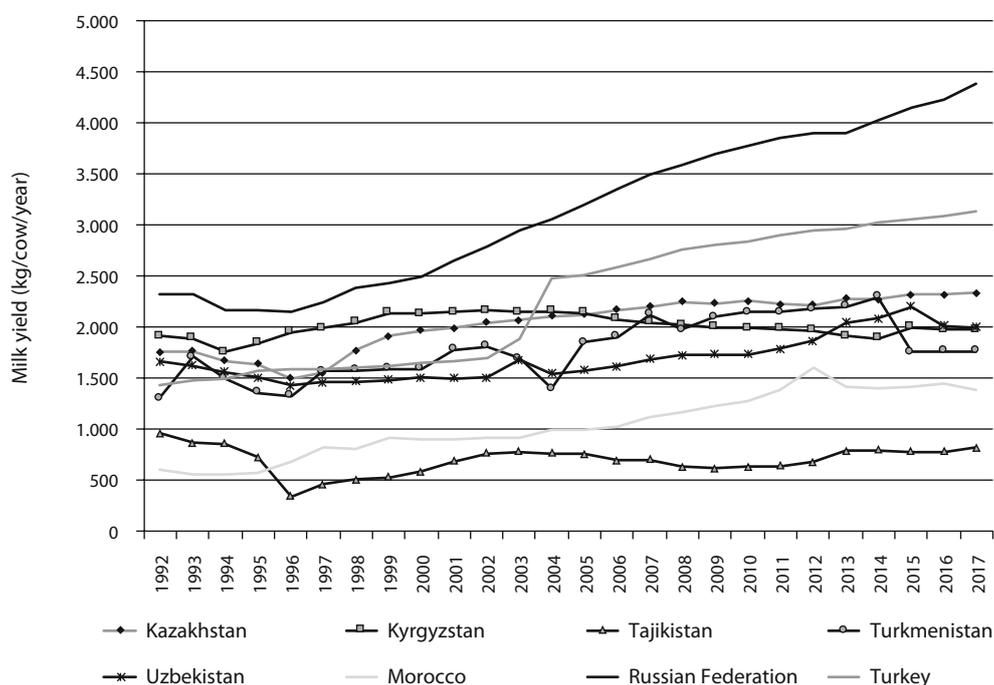


Figure 7 Milk yields in Central Asian and selected emerging economies

Source: FAOSTAT.

**Animal performance.** Concerning milk yields, international comparisons are unfavourable (Figure 7)<sup>13</sup> and only Uzbekistan exhibits recent and sustained increases. Other republics exhibit stubbornly low yields, although averages can mask real change: in Kazakhstan yields in enterprises, with access to pedigree animals and subsidies, reached almost double the national average at around 4338 kg/cow/year in 2017 (ANICANET database). High yields in enterprises are also evident in Kyrgyzstan and Tajikistan (ANICANET database) but their performance is much poorer in Turkmenistan, where these (mostly state) structures record mean yields only half those of small private owners (Aganov et al. 2019).<sup>14</sup> In Tajikistan as a whole, milk yields are both stagnant and abysmal reflecting severe nutritional constraints. Calving rates at 65% are still well below 1991 levels of 75% (national statistics in Umarov (2017)) whilst in Kazakhstan, from a nadir of 65% in the 1990s they bounced back to 85% by 2001 (Government of Kazakhstan and the World Bank 2004).

13 In Europe and the US, yields are closer to 8000kg/cow/year, double that of the best performing country in Figure 7.

14 Based on State Committee of Statistics of Turkmenistan: Economic efficiency of the agriculture with consideration of the resource provision. Analytical paper, Ashgabat, 2014.

## 2.6 | Current reforms and policy issues

**Support to farmers.** In Uzbekistan, a livestock sector programme initiated in 2006 included (i) provision of 100,000 cows for low-income families at the expense of sponsors and entrepreneurs; (ii) subsidised loans for livestock production and (iii) creation of field outlets for cotton husks and sunflower seed (Naumov and Pugach 2019).<sup>15</sup> There followed a short term increase in the number of farms specializing in livestock raising and in the overall number of livestock in farms, but this did not reverse the longer term trend of decreasing proportion of livestock in farms and enterprises compared to households. Uzbeks have the lowest access to financial services in Central Asia.<sup>16</sup> There are a number of public and private banks that operate in the agricultural sector, but interest rates (at 18–24% per annum) are prohibitive. Some banks recently announced state support for rural loans to small farmers and households without collateral, but significant administrative obstacles are likely to negatively affect demand (Naumov and Pugach 2019).

Kazakhstan has a vast subsidy programme of which the latest iteration allocates 35.9 billion tenge (92 million USD)<sup>17</sup> for subsidies to investment in livestock from 2017 to 2021.<sup>18</sup> These include 50% payments towards pedigree livestock, support for feedlots, output subsidies for raw produce sold to processors, and a number of credit lines with subsidised interest rates.<sup>19</sup> Per hectare crop input subsidies supported feed production but have recently been cut back. However some form of input provision is likely to continue, and some payments have increased, in particular for seed production (OECD 2019). Until recently the bulk of government support went to very large farms and enterprises (conditions specify minimum herd sizes, animal weights at sale or hectares planted). The new programme still includes these conditions, but also aims to reach small and medium-sized farms by linking subsidies to cooperatives whose members individually would not meet the scale criteria. Although most subsidies promote intensification, funds for well and winter house rehabilitation also demonstrate a desire to bring abandoned pasture back into use. The 2017–2021 programme also commits significant investments for irrigation, which will perhaps go some way to improving the fodder base (Petrick et al. 2018).

Beef has been identified as a major long-term priority and has its own national programme (Ministry of Agriculture of the Republic of Kazakhstan 2018). This foresees establishment of large feedlots and processing facilities in selected regions of the country with a view to export. Kazakhstan's membership of the Eurasian Economic Union (EAEU) (along with Kyrgyzstan) will lead to harmonisation of standards and improved access to markets in Russia. Negotiations on harmonisation of veterinary and phytosanitary standards with countries such as China, Iran and Saudi Arabia, where demand for meat is strong, are ongoing (Ministry of Agriculture of the Republic of

15 The programme also organized sale of pedigree cattle through auctions to farmers between 2006 and 2010 and expanded microcredit for households (Lerman 2008).

16 World Bank Global Findex database (2017).

17 The exchange rates used to convert local currencies to USD were from 1 November 2019 (390KZT = 1USD).

18 <https://moa.gov.kz/ru/documents/2>. State Program for the Development of the Agro industrial Complex 2017–2021. Total budget for programme is 2374 billion tenge or 6.1 billion USD including all credit, investment, subsidies (53%) research, marketing (Petrick et al. 2018).

19 At 118 million USD, financial services made up over 50% of the total agricultural budget in 2017 (Mussayeva 2018).

Kazakhstan 2018, OECD 2019). These efforts include animal identification and electronic traceability systems; abattoir improvement; and disease control programmes, recently rewarded by international recognition of Kazakhstan as a foot and mouth free zone (Oshakbayev and Bozayeva 2019).

In Kyrgyzstan there is no specific agricultural programme and broader national development strategies are the documents of reference (Niiazaliev and Tilekeyev 2019). Membership of the EAEU has spurred some concrete steps towards modernization and commercialization, among them the law “On animal identification” to establish a system of animal tracking and product traceability. Thus far, only cattle have been issued with identification numbers and there has been little progress to track movement, vaccination or births. Most abattoirs do not meet EAEU sanitary norms meaning that producers cannot legally capitalise on membership through export, even to neighbours such as Kazakhstan (UNIDO 2018). International support to implementation of the 2009 Law on Pastures is ongoing, combined with local experimentation, research and assessment (e.g. Mestre 2017, Shigaeva et al. 2016). Various input-related subsidies have been available on an irregular basis over the years (Zhunusova 2017) and the Agricultural Financing programme subsidises interest rates of partnering banks, limiting these to ten percent (O’Connell and Kiparisov 2018).

Turkmenistan has a number of loan programmes, mostly aimed at large investments in livestock production and processing. There is no targeted support for family farms, but provision of cheap electricity and fuel supported water pumping and transport to outlying pasture until recently, when the current economic crisis in the country forced price increases. The state has recently introduced private-public investments in large intensive cattle production complexes, through concessional agreements in which the facility is operated by the private company for a set period. These enterprises are vertically integrated, from the cultivation of fodder crops to processing into goods ready for sale (Aganov et al. 2019).

In Tajikistan there are no subsidies to speak of, with most farmer support provided by international donors, but the government heavily subsidises electricity for irrigation (Shenhav et al. 2019). A law on cooperatives was passed in 2013 with the intention of facilitating rural service provision (Lerman and Sedik 2014).

**Ongoing land and structural reform.** A 2019 resolution allocates rainfed land and pasture to livestock farms in Uzbekistan from the district land reserves. Land is allocated with the obligation to grow fodder crops and introduce a drip or sprinkling irrigation system. In return for subsidies, farmers may apply for bank loans at a reduced interest rate and customs privileges. Uzbekistan is also trying to improve product processing by obliging producers to engage in this activity. From 2022, land lease agreements with farms that have not included processing in their activities will be terminated (Naumov and Pugach 2019). In contrast, Kazakhstan is trying to use subsidies to promote the voluntary establishment of producer-processor cooperatives.

In 2016, Kazakhstan attempted to amend the Land Code. Amongst the proposed changes, new applications for state land by Kazakh nationals were to concern private ownership only, with initial

land auctions aiming to fetch above market prices (land failing to sell under these conditions could subsequently be re-auctioned with a floor of 50% of market price). All existing leaseholders were to be given the option of purchasing their parcel at 50% of market price, paying in instalments over ten years (Government of Kazakhstan 2015). But the proposed changes effectively abolish new leaseholds for Kazakh citizens, as land reverts to the state once leaseholds come to an end. This risks depriving many farmers of access to land, as privatisation by purchase is much more expensive than leasehold. Following protests (which largely concerned clauses in the same document extending the duration of leaseholds for foreigners), there is currently a moratorium on this and other amendments until 2021. Unfortunately the moratorium included suspension of all land privatisation and sales, although these had been possible since 2005.

Leasing markets remain inefficient, with no easy process for transfer of leaseholds back to districts for redistribution or directly between farmers (something the amendments also attempted to redress). A proportion of land under held lease is thus unused. In response, the Kazakh government is currently attempting to identify and expropriate this land for redistribution. A 2017 Law on Pastures introduces the idea of district level pasture use planning, including provision of pasture to those currently lacking access. But the law provides no legal instruments to realise this other than the aforementioned seizure and redistribution of unused leaseholds or informal short term agreements for use of the land reserve. Uzbekistan too has just brought in a Law on Pastures and in June 2019 a new version of the 2013 Tajik law was approved (Jumabayeva and Karimov 2017). Bylaws have not yet been designed and it is unclear whether either of these laws will improve legal access to seasonal pasture by collectively managed herds.

Turkmenistan is currently planning far-reaching land reforms with the aim of transferring large areas of land from state livestock enterprises and some farmers associations to the private sector. The 2018 decree<sup>20</sup> governing this process specifies that a new land fund from arable lands of farmers associations will be made available to private entities (including private farms) for 99 years. But 70% of this land is subject to state plans (for which the government plans to raise procurement prices). Concurrently, cheap credit lines will be provided to facilitate the transfer of premises and livestock from state livestock enterprises to the private sector - together with the allocation of land. A number of former state livestock facilities have already been sold to investors by tender (Aganov et al. 2019). At the same time, the 2015 Law on Pastures includes provisions for devolution of pasture management to local Commissions, which allocate land to users on a short term leasehold basis (Robinson et al. 2018). It is not clear which of the two legislative instruments will take precedence. In Uzbekistan, there has been a relaxation of government plans for cotton and wheat but newly authorised crops are also subject to targets. Inputs continue to be subject to government monopolies, with priority given to cotton and wheat (Zorya et al. 2019).

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20 Presidential decree On further improvement of reforms in the agricultural sector, 25.09.2018.

### 3 \ Highlights from country case studies

In this section we present key observations from fieldwork in Almaty region of Kazakhstan, Chui region of Kyrgyzstan and Kashkadarya in Uzbekistan, focussing on market participation and feeding (see Annex 1 for details of geographical scope and a map of study sites). Figures in tables represent data from quantitative surveys and are presented by farm type and size, according to the sampling strategy in each country. Qualitative interviews with farmers; various actors across value chains and officials responsible for land, subsidies and sanitation were also conducted.

**Survey Sampling.** In all three countries, only households and farms owning cattle were sampled, with the Kyrgyzstan sample restricted to those owning five or more head and the others including those having any cattle. In Kyrgyzstan there was no stratification by household and farm as these groups are not highly differentiated in reality; thus the 250 sampled respondents are presented by cattle ownership quartile (based on cattle numbers weighted by age).<sup>21</sup> In Kazakhstan, 50 households and 200 family farms were sampled using different methods (farmers from lists and households through random visits). Farms were then broken down into quartiles based on cattle ownership (total cattle numbers, unweighted for age). In Uzbekistan the data reflect the sample stratification into 152 households, 73 mixed farms and 76 livestock-specialised farms, all selected from separate lists. See Annex 1 for more detailed information.

#### 3.1 | Market participation

**Dairy value chains.** These exhibit quite different characteristics at the three study sites (Table 5; Figure 8). In Kazakhstan, there are three main types of value chain including (i) home processing for self-consumption and sale to neighbours and traders; (ii) localized dairy plants collecting milk from nearby villages; (iii) large dairy processing plants able to collect milk from a large area but also using imported powdered milk. In Almaty region, the first and particularly the third type are most prevalent and eighteen large dairy companies with a total annual capacity of 180kt are located in the region. Although companies have their own collection schemes, milk is also collected by small traders and the length of supply chains means that around 35 percent of the price paid by processors goes to intermediaries (Oshakbayev and Bozayeva 2019). Although part of the study site is only two hours from Almaty, other areas are up to five hours distant with little arable land and extensive pastoral resources. These areas focus on beef production and have low frequency of milk sales.

In the Chui valley of Kyrgyzstan, milk producers of all scales sell to processors near Bishkek through a chain of village-level traders. This system is well developed enough that few farms sell through any other channel. In Kashkadarya (Uzbekistan), households are not generally integrated into value chains to large scale processors and are much more likely to sell in the market and to neighbours. Sixty-seven percent of livestock-specialised farms sell directly to processing

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21 Based on [https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Livestock\\_unit\\_\(LSU\)](https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Livestock_unit_(LSU)).

enterprises, a sales pattern rare in the other two countries - although the sampling regime in Uzbekistan was designed to capture exactly these types of specialised farms. Thus, some processing enterprises purposefully work with farms. Others prefer to keep their own dairy herd, buying additional milk from households and farms. Some maintain long-term relationships with milk traders, but it is unclear why the importance of such intermediaries is so much lower at the Uzbek site than in the Chui valley.

Uzbek supermarkets are taking on more and more local produce and the share of imported dairy products has declined in recent years, however many manufacturers prefer not to sell their products via this channel due to pricing systems (buying low and selling high) and merchandising requirements. Some look for alternative retail sales options (organizing their own outlets or selling from cars in cities) or sell products to wholesalers (Naumov and Pugach 2019).

Table 5 Proportions of household and farms selling livestock products

Farm type*	Kazakhstan					Kyrgyzstan				Uzbekistan		
	HH	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	HH	MF	LSF
N	50	56	49	45	50	63	62	63	62	152	73	76
Mean cattle (LSU)	6.8	6.0	10.2	18.1	68.3	3.9	6.2	9.8	23.8	3.9	7.2	39.4
Mean cattle (head)	8.7	8.0	14.1	24.3	85.5	5.7	8.4	13.2	31.2	4.9	9.0	49.3
Sells:												
Milk (%)	10	4	12	16	6	62	82	79	87	20	29	78
Milk products (%)	4	4	8	11	14	0	0	0	0	9	10	9
Beef (%)	10	5	8	13	18	0	0	2	5	32	37	67
Live cattle (%)	44	27	51	71	64	65	66	73	77	52	56	78

\*HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Sources: ANICANET field survey data & Naumov and Pugach (2019).

In all republics, milk prices are a function of quality, depending primarily on fat and protein content, with highest quality milk 38% more expensive than lowest quality in Kazakhstan (Oshakbayev and Bozayeva 2019). The quality of milk from smaller operations tends to be lower - for example, in Uzbekistan mean fat content of milk produced by households is 2%, whilst the equivalent figure amongst farmers is 3.2–3.5% (Naumov and Pugach 2019). Prices are generally higher in winter, but in Kazakhstan, low volumes may mean that collection ceases at this time. In Kyrgyzstan it was demonstrated that prices also depends on volume, proximity to processors and number of middlemen - which form cartels (Niiiazaliev and Tilekeyev 2019). In both Uzbekistan and Kyrgyzstan milk yield per cow is higher in larger structures, related to better feeding and higher prevalence of pedigree animals (Table 6). In all three republics the existence of collective infrastructure at the village level for cooling or freezing is unusual. In Kazakhstan subsidies aimed at cooperatives were put in place to finance such facilities, but bureaucratic difficulties associated with cooperative establishment and subsidy receipt remain.

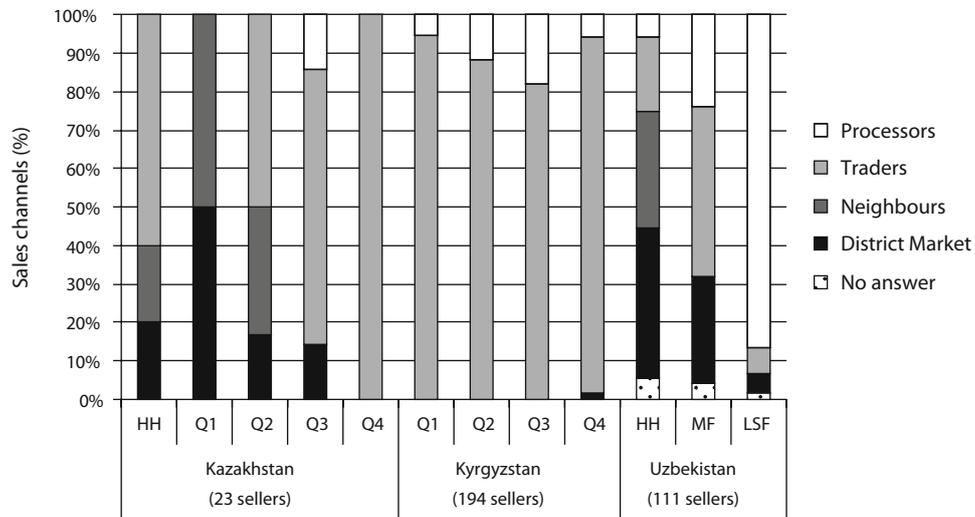


Figure 8 Sales channels for raw milk at the three study sites

\*HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Source: ANICANET survey data.

**Beef value chains.** These are more complex, involving markets, traders, abattoirs, feedlots and retailers. Most cattle are sold live in all three countries, whilst beef sales are less common. Only in Uzbekistan do relatively large numbers of farmers sell beef directly to processors (12% of live-stock specialised farmers sell to processors although more sell to markets (17%) and traders (26%), Naumov and Pugach (2019). Elsewhere, beef sales take place through district bazaars, neighbours and traders.

For farmers, primary sales channels for live animals are local traders and district markets, few producers are able to sell directly to regional markets, feedlots or large processors.<sup>22</sup> Almost all pass via intermediaries, thus losing value and missing out on output subsidies (which are not available through these channels). In Kazakhstan, live animals may be transported over vast distances. For example, cattle purchased in Eastern Kazakhstan may be sold in Almaty and transported to feedlots in Southern Kazakhstan. The fattened animals are then often re-sold to markets in Almaty. However, close to Almaty there are also many smaller scale fattening enterprises which purchase animals at markets. Some farmers fatten cattle themselves before sale, but these tend to be those farmers able to produce high quality fodder themselves, or smaller producers with poor access to pastures. A lack of local certified abattoirs is a constraint in the Almaty area, these being available only in the city and an obligatory step for subsidy receipt. In Kyrgyzstan also almost all sales were made to markets or mobile traders (Niiazaliev and Tilekeyev 2019). However some traders are themselves feedlot owners. There are around 500 of these in Chui province and it has been estimated that 50% of all cattle raised in these feedlots are sold live into the Kazakhstan market

22 In contrast large enterprises sell to processors (50%), export markets (30%) and only 20% to intermediaries (Petrick et al. 2018).

illegally (Wilkes and Merger 2014). Only in Uzbekistan did significant numbers of respondents (16% of livestock farmers and a small number of households) sell live cattle on a contract basis.

### 3.2 | Pasture access and fodder provision

Constraints related to fodder and pasture access show contrasting patterns in the three case study areas (Table 6; Figure 9). At all three sites, access to remote pastures is positively associated with herd size and (at the Kazakh and Kyrgyz sites) negatively associated with provision of supplementary fodder - a pattern observed also in central Kazakhstan (Kerven et al. 2004, 2016). The proximity of the Kyrgyz site to large arable areas and a focus on dairy mean that fodder provision is higher across the board than at the Kazakh site and farms of all scales are much more ready to purchase concentrate. In Uzbekistan, mixed farms are able to provide the highest quantity and quality of fodder per animal from their own production whilst livestock specialised farms use a mixture of pasture and self-produced fodder over the year.

Table 6 Access to land and pasture

Farm type	Kazakhstan					Kyrgyzstan				Uzbekistan		
	HH	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	HH	MF	LSF
N	50	56	49	45	50	63	62	63	62	152	73	76
Mobile (using remote pastures) (%)	28	57	61	84	88	21	27	30	50	2	10	29
Frequency of access to cropland (%)	80	88	92	82	84	54	58	71	92	98	97	97
Mean area of cropland (ha), users only.	1.5	4.0	13.4	7.2	25.5	5.5	14.8	10.0	18.8	0.79	37.8	40.8
Frequency of access to hay land (%)	52	64	71	78	74	3	8	14	18	7	17	4
Frequency of legal access to pasture (%)*	10	50	61	71	84	59	85	71	76	0	1	18
Winter feed considered insufficient (%)**	58	61	45	42	40	27	27	19	19	60	36	38
Mean milk yield/cow (kg)***	1076***					2187	2257	2237	2536	1778	1966	2198

HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Source: ANICANET survey data.

\* Leasing contract in Uzbekistan and Kazakhstan; purchase of pasture tickets in Kyrgyzstan.

\*\*Respondent indicates that animals lost weight over winter.

\*\*\* Sellers only; in Kazakhstan only 23 household sell raw milk so figures are not disaggregated by farm type.

**Pasture access.** At the Uzbek site, ANICANET survey data suggest that 87% of households and 51% of specialized farms do not use pastures at all. Instead, many graze around villages, along roads, or on fields after harvest. At the Kyrgyz site, the probability of pasture usage by a farmer

who holds less than four cattle is zero, but otherwise most sedentary owners use village pastures at some point and 80 (~30%) use remote pastures (Niiazaliev and Tilekeyev 2019). The villagers in the study area all have legal access to summer pastures in the Tien Shan Mountains, but these are distant and those holding cattle primarily for milking cannot send dairy animals to these areas. At the Kazakh site, large areas of seasonal pastures, including winter areas, exist but not all are easily accessible (physically or administratively) and around 28% of farms and 72% of households have no mobile animals at all - using only village pastures. Local policies are quite varied - interviews suggested that in some areas most pasture outside village lands is occupied by leaseholders, leaving only the most inaccessible reserve lands for collective use. In other areas local governments set aside accessible reserve areas for summer use by non-leaseholders.

**Fodder provision.** Of the Kazakh farm sample, 100% provide roughage and 89% concentrate. The latter is more frequently purchased than self-produced (68% and 25% of farms respectively). Roughage is mostly self-produced (except in households, of which 72% buy) and comprises natural hay and cultivated lucerne or sainfoin. It is notable that farms at the Kazakh site provide almost no silage and three and eight times less concentrate than those in the Uzbek and Kyrgyz samples respectively. There is a negative relationship between the amount of roughage and concentrates provided and herd size, with larger farmers able to use pastures instead.

At the Kyrgyz and Uzbek sites, rations are more varied than at the Kazakh site. In the Chui valley, cattle are often stall fed on spent grain from breweries and various waste products from sugar production, purchased on the market. Half of farms, mostly larger operations, grow wheat and hay themselves, whilst half buy these commodities on the market (Niiazaliev and Tilekeyev 2019). In Uzbekistan, interviewed households grow mainly cultivated hay (29%) and corn silage (30%) and purchase mixed fodder (69%). Farms grow grass for silage (45%), produce oil cake (33%), and buy mixed fodder (80%) with government-supported feed points playing a significant role (Naumov and Pugach 2019).

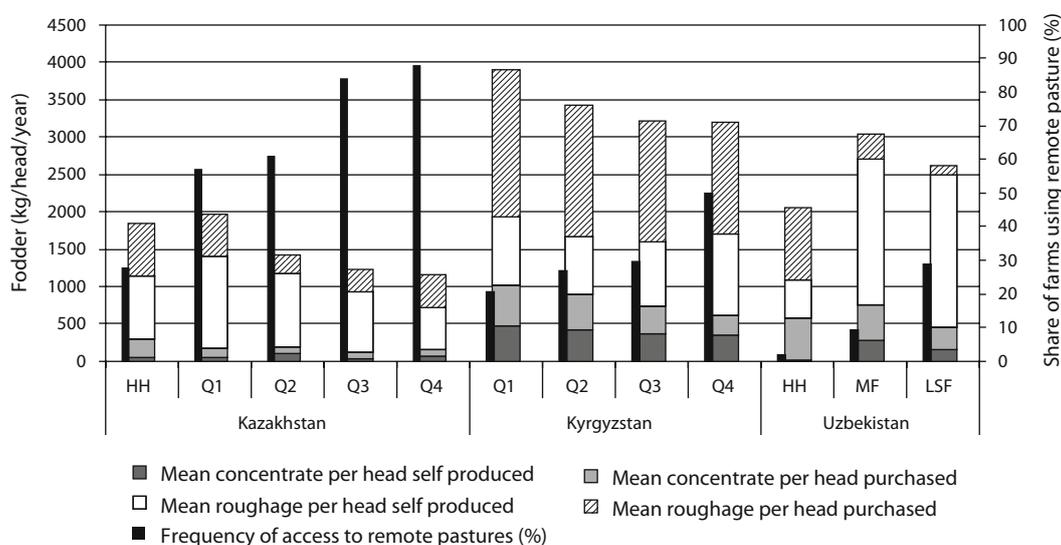


Figure 9 Access to remote pastures and fodder provision by farm type

\*HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Source: ANICANET survey data.

Note: Outliers over three times the inter-quartile range have been removed. In Kyrgyzstan, remaining high values are associated with large proportions of crop residue in the total ration. Some of these residues (listed under roughage), such as spent grain from beer production and various waste products from sugar-beet have a high water content, which may partially account for high values at that site.

In all study areas, the smaller herds are the poorest fed in winter, with small farmers more likely to say that their animals lose weight in winter and largest most likely to say that they gain weight. About 70% of farmers at Kyrgyz and Uzbek sites state that they are unable to purchase sufficient fodder for financial reasons. Naumov and Pugach (2019) suggest that even at current concentrate prices, improved feeding should return greater profits from milk yields. Certainly, differences in feeding observed between study sites are directly reflected in yields, which are highest in Kyrgyzstan. The close proximity to markets for milk at Kyrgyz and Uzbek sites and more agro-pastoral nature of the production systems there seems to both incentivise and enable higher quality of feeding, whilst at the Kazakh site animals are kept at a lower plane of nutrition in the winter (see also Ur-Rahim et al. (2014) on relationship between proximity to markets and winter nutrition of cattle in Kyrgyzstan).

### 3.3 | Credit and subsidies

**Credit.** Overall credit uptake in the three years to the survey was highest in Kyrgyzstan (44%) followed by Kazakhstan (14%) and Uzbekistan (10%).<sup>23</sup> Eighteen percent of the Kyrgyz sample used a loan for farm investments in the year up to the survey, but in the other two republics far fewer farmers (and zero households) used loans in this way. In Uzbekistan, banks are more likely to approve loans to farms than to households, but many of the latter stated that they did not need or want a loan. Larger farms require more financial resources for development and were more likely to apply.

At the Kazakh site, about half of those who received credit did not receive the amount they requested. These, along with those who had applications rejected are quantity rationed (ready to take credit under market conditions but not fully served by the provider).

At all sites, of non-applicants stating that they would like to have taken credit, most gave multiple reasons for not applying. Price (interest rate), risk (including a preference to work with own money) and transaction costs were mentioned in decreasing order of frequency (Figure 10) and in Kazakhstan in particular the number of those indicating a need for credit was far larger than those who applied. This pattern reflects results found by Petrick et al. (2017) for Kazakhstan which found credit uptake was constrained by a lack of effective demand than lack of success by applicants, as farmers doubt their ability to repay loans. Similarly, at the Kyrgyz site, where credit uptake is largest, numbers expressing a need for credit who did not apply are also very high. Here, transaction costs are particularly low, so risk aversion may be the main factor dissuading potential applicants. In Uzbekistan a large proportion of non-applicants stated that they did not need credit at all, but this may also be an indirect expression of risk avoidance.

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23 Other sources also suggest that rural Kyrgyz have better access to credit than those of similar countries in the region but that most loans are taken to finance production costs rather than on-farm investments (IFAD 2016).

Table 7 Access to loans and subsidies

Farm type*	Kazakhstan					Kyrgyzstan				Uzbekistan		
	HH	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	HH	MF	LSF
Need credit (%)**	58	50	89	27	34	36	58	50	89	27	34	36
Applied for (any type) of credit (%)***	18	14	12	24	26	29	47	52	53	16	11	20
Received credit (%)	14	13	8	9	24	29	45	52	50	7	8	18
Success rate (%)	78	88	67	36	92	100	97	94	97	46	75	93
Received any subsidy (%)	0	0	4	2	30	2	0	3	6	64†	53	71
Used loan for investment in agriculture (%)	0	4	0	2	12	10	18	19	24	0	5	9

\*HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Source: ANICANET survey data.

\*\* These respondents either applied for credit or did not apply but specified that lack of need was not a reason for non-application.

\*\*\* Three Uzbek respondents receiving credit were not listed as applying, leading to slight overestimation in success rate (Naumov and Pugach 2019).

† These households did not themselves receive subsidies, but may benefit indirectly as sharecroppers on farm land.

**Subsidies.** In Uzbekistan, on average 62% of respondents received production subsidies issued for cultivation of agricultural products under state orders, mainly for the purchase of fuel, seeds, fertilisers and machinery services. Households claiming that they 'received' these subsidies were actually hired workers or share croppers on farms growing cotton and grains and are not in fact primary recipients. Farmers do not receive subsidies for livestock production. In Kyrgyzstan few received subsidies other than the loans mentioned above. In Kazakhstan subsidies were almost exclusively received by the top cattle ownership quartile (Q4), with most frequent types being subsidised pedigree bulls (6% of all farms; 24% of Q4) and machinery purchase/lease arrangements (3% of farms; 8% in Q4). Interviews suggested that for smaller farmers, obtaining subsidies was almost impossible due to scale conditions and transaction costs.

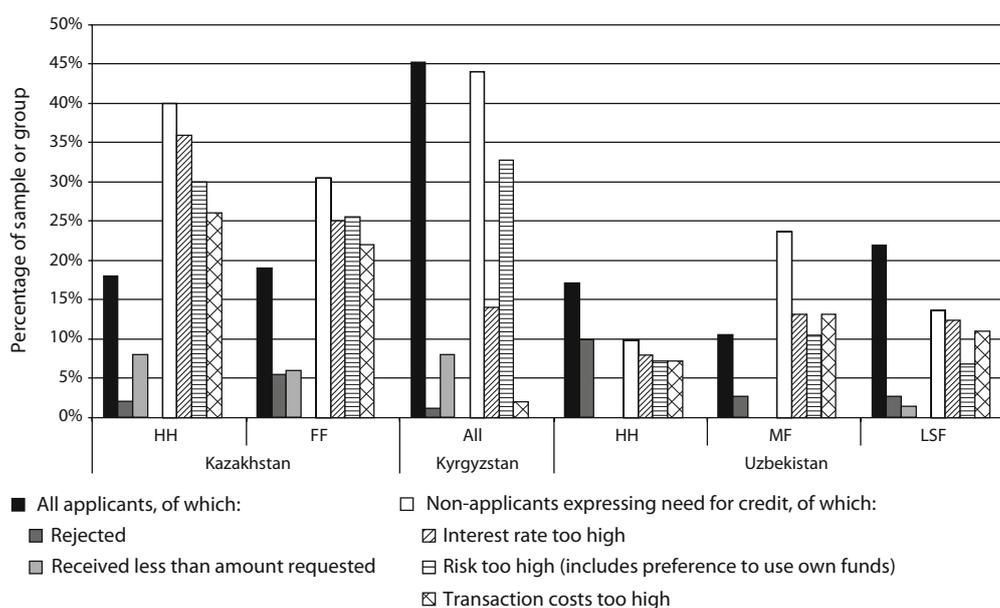


Figure 10 Results of credit applications and reasons for non-application

\*HH=Household; FF= Family Farm; MF = mixed farm; LSF = livestock specialised farm. Multiple answers possible.

Source: ANICANET survey data.

### 3.4 | Constraints to development of the livestock sector

Barriers mentioned by survey respondents. The major barriers to farm expansion mentioned in surveys and interviews are summarized in Table 8.

Table 8 Most frequently cited barriers to development (up to three responses were possible; only most common barriers listed)

Barrier	Kazakhstan					Kyrgyzstan				Uzbekistan		
	HH	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	HH	MF	LSF
Access to pasture (%)	36	30	29	36	40	44	39	41	40	50	20	29
Land for fodder production (%)	36	14	14	22	24	27	27	22	29	80	76	79
Other issues related to feed/fodder (%)	12	11	14	16	14	13	6	10	13	68	77	85
Lack of finance (%)	28	21	27	40	22	40	40	35	48	4	3	4
Water (%)	6	4	16	13	14	10	13	13	10	18	17	18
Marketing (%)	10	7	6	22	6	3	3	8	3	0	0	0

\*\*HH=Household; Q= quartiles based on number of cattle owned (Kazakhstan) or cattle units owned (Kyrgyzstan); MF = mixed farm; LSF = livestock specialised farm

Source: ANICANET survey data.

Access to finance topped the list in Kazakhstan and Kyrgyzstan, with poor access to pasture and lack of land to grow fodder mentioned at high frequency in all three republics. The proportion mentioning these barriers is remarkably similar across farm sizes, although in Uzbekistan access to pastures was a particularly important issue for households. In both Kyrgyzstan and Kazakhstan market access was mentioned in around 10% of cases. Animal health was considered a serious development obstacle by 18% of Kyrgyz respondents and this issue is a major barrier to value chain development in that country (UNIDO 2018). The most common reason given for difficulties accessing land was that most is already claimed by others, but in Uzbekistan and Kazakhstan high cost and complexity of land acquisition were also significant. Twenty percent of Uzbek respondents mentioned lack of water in pastures whilst at the Kyrgyz site, distance to pastures was more important.

## 4 \ Conclusions and outlook

### 4.1 | Summary of key points

**Farm structures.** The livestock sector is highly fragmented into large numbers of small producers, a small number of very large enterprises, and family farms which come somewhere in between. Generally large enterprises capture the lions' share of assets and government subsidies although these are not necessarily the most efficient producers. Most enterprises are state run, others private but inefficient or subsidised. Outside Kyrgyzstan there is a particularly wide mismatch between the proportion of livestock inventories found in households, and the assets available to these producers. In Uzbekistan this pattern has been exaggerated by policy - with households specifically denied access to land or pasture and unable to independently buy feed on commodity exchanges, whilst the status of farmer is difficult to attain. This would not be an issue were households gainfully employed elsewhere but studies have shown that, taking all income sources into account, households are on average poorer than farmers (Lerman 2008). Farmers are also subject to unpredictable policy decisions such as forced consolidation, which sent a negative signal regarding the leasehold security (see also Djanibekov et al. 2012). Kyrgyzstan has a more equal land access structure, but there were still few large farms in the sample; to enable further consolidation and investment, other sectors of the economy must absorb smallholders – a challenge certainly not unique to Kyrgyzstan or to Central Asia.

**Market development.** In all three countries a large number of small producers are unable reach the scale needed to sell directly to processing enterprises. Kazakhstan has gone some way towards consolidation, with some very large enterprises and a growing family farm sector. But lack of volume and reliable supply to processors in cities still hampers both domestic supply and export prospects (Oshakbayev and Bozayeva 2019). Suppliers of all sizes close to very large cities such as Bishkek are well integrated with milk processors and animal markets via traders. At other study sites there was a much greater difference in market participation with scale, in particularly at the Uzbek site where large specialised livestock farms sell products directly to processors but others are more likely to sell though informal channels despite proximity to urban areas. The

consequences of a lack of decentralised processing facilities is most visible at the Kazakh site where distance from the capital is negatively associated with frequency of milk sale. Although probability of selling live animals is not affected by distance to markets, only a tiny number of producers can afford to transport animals themselves or attain the volumes required to negotiate contracts directly with processors or abattoirs. It is at this site that improved transport infrastructure, delocalised processing and marketing systems would have the greatest impact. Policy solutions in Kazakhstan have included support to cooperatives to allow small farmers to create economies of scale, but rules for cooperative formation and conditionality for subsidy receipt are significant barriers. Across the region it has been noted that confusion between service and production cooperatives and inappropriate taxation reduce the potential of cooperatives to support small farmers to access inputs and markets (Lerman and Sedik 2014, Petrick et al. 2018).

**Animal nutrition.** The area planted to fodder crops has increased in Kazakhstan and Kyrgyzstan in recent years although in other republics expansion is held back by state plans for other crops. In some cases the proportion of cereals used for feed is also increasing, but overall supplement provision is still well below levels provided in the 1980s. Both volumes and quality of fodder provision are lower in more mobile meat based systems, with peri-urban or dairy operations providing more in the way of concentrate and crop waste.

Smaller farms, and particularly households which hold the bulk of livestock inventories, have the poorest access to pasture. Their animals remain around settlements, leading to highly uneven livestock distributions. Mechanisms need to be found for provision of legal access to pastures by smallholders and for ecosystem level management to optimise use of seasonal vegetation peaks in different seasons and locations. The 2017 Kazakh Law on Pastures achieves neither of these aims. In Kyrgyzstan, the common property system resolves these issues in theory, but power symmetries amongst users still exist (Kasymov and Thiel 2019), and economic barriers remain when pastures are far away, as evidenced by low use of mountain pastures in our sample. In Turkmenistan and Uzbekistan pastoral land reform is only just beginning, but massive investments in water supply would be needed to bring desert pastures back into use. In both republics, increases in fodder and feed production will require abolition of state plans, creation of a free market for agricultural raw materials, protection of property rights, deregulation of the combined feed industry and improved management of irrigation. It is notable that Kyrgyzstan, in which livestock and land ownership are most closely aligned, has the highest proportion of arable land under fodder; the deep structural reforms which occurred there may facilitate the ability of farmers to respond to market demand.

To improve feed conversion efficiency per animal and provide large volumes of meat for processing (and eventually export), a number of republics are investing in very large feedlots. Studies in Kazakhstan suggest that these are only likely to be profitable for finishing (i.e. if substantial areas of pasture are available for earlier growth stages (FAO Investment Centre 2010b)). Those in Turkmenistan seem likely to be highly subsidised. Although such industrial feedlots could potentially purchase young animals directly from producers, this appears to be rare at the Kazakh site. However, some producers do sell (via traders) to feedlots in other regions, or to smaller local finishing enterprises, which could perhaps be better supported. Improving animal productivity

also requires genetic improvements, for which Kazakhstan has a large subsidy programme. But those farmers large enough to be eligible for subsidised pedigree bulls are often rather low-intensity operations unlikely to provide the quality of feed for these animals to reach full potential, especially if they are not integrated with finishing operations.

## 4.2 | **Emerging types of livestock producer**

The survey sites illustrate a number of key points on the influence of location and scale on marketing and feeding summarised in [Table 5](#) and [Figure 9](#) of this report.

**Large extensive operations.** At the Kazakh site, a small group of very large herders has developed, with high mobility and relatively low use of supplementary feed per animal. Mobile systems generally have a low impact on vegetation and on carbon loss from soils, whilst minimising opportunity costs associated with fodder production as much of this is produced on marginal lands. However they also produce poorly productive animals and high GHG emissions per unit of product. Finishing would improve efficiency and, although direct sales to feedlots are few, an unknown proportion of animals are sent for fattening elsewhere via intermediaries. This recourse to middlemen means that few benefit from higher prices at regional markets or from direct sales to processors.

- **Small and medium operations in pastoral areas.** A combination of grazing on village pastures with greater use of supplements is common amongst smaller owners in extensive areas. These producers are caught between lack of access to remote pastures and the high cost of purchasing feed, and are unlikely to benefit from credit and subsidies. Likewise, the typical combination of small product volume and distance from markets means that many of these farms produce for themselves only or rely on personal connections in town to market produce.
- **At peri-urban and agro-pastoral sites,** better market participation facilitates improved animal nutrition in winter relative to pastoral areas and a greater specialisation in dairy. Use of concentrate, silage and crop side-products means that fodder digestibility and conversion efficiency are likely to be higher but animals are often sold later and access to cropland or cheap sources of feed are essential for farm development. However, even in these areas, the ability to scale up is clearly linked to remote pasture access and larger farms have very high rates of use of mountain grazing in summer. In Uzbekistan this concerns a small and specialised set of farmers - which is also the most market-integrated group in the study, having a high frequency of direct sales to milk or meat processors. Other producers, even large farmers near Bishkek, rely on intermediaries for sales to feedlots, slaughterhouses or processors.

### 4.3 | **Government support to the sector**

Across the region, livestock inventories continue to grow, but large scale commercialisation is slow and limited to a very small number of farmers. Greater alignment between land access and livestock ownership, through collective herding systems and improved infrastructure in pastures combined with legal changes facilitating secure access to cropland in Uzbekistan and Turkmenistan, would improve access to forage and fodder for small producers.

Although amongst some groups (such as Uzbek households), demand for credit is clearly unmet, others (smaller Kazakh producers and a large proportion of Kyrgyz producers) exhibit low effective demand as producers are not confident that they can generate the revenue needed for reimbursement. Such producers could be better targeted by non-loan forms of government support such as subsidies, support for marketing and investment in infrastructure.

Currently, subsidies tend to magnify the differences between small and large producers; support is often provided largely to wealthy entrepreneurs - particularly in Turkmenistan. In Kazakhstan, a high proportion of subsidies goes to the largest family farms, but even more goes to enterprises – the least efficient producers (Petrick et al. 2018). Disbursement is linked to direct sale to processors and abattoirs which are unavailable in rural areas, shutting out smaller producers.

Decentralised processing in remote areas combined with the appropriate infrastructure investment to make this viable; improved institutional design of service cooperatives and experimentation with other marketing instruments would support small and medium producers to access value chains. In Uzbekistan, government feed distribution points could be targeted towards small producers who cannot access commodity exchanges.

In Kyrgyzstan, family farms are the major producers and disparities in access to land and means of production are lower than in other republics. But although our study site was close to a city, much of the country is remote. In such areas, improved public investment in transport infrastructure, veterinary services and food safety, would support the livestock sector as a whole and raise its profitability, thus improving the credit worthiness of farmers.

The export of livestock products is an aim which regularly appears in government strategy documents across the region. But the investments in animal health and certified slaughtering systems required for international agreements and product certification has so far been limited to Kazakhstan. Kyrgyzstan, as the other regional EAEU member, would in particular benefit from investment in these areas to legalise and expand cross border sales.

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## ANNEX 1. QUANTITATIVE SURVEY METHODS AND STUDY SITE LOCATIONS

### Site selection

The locations of study site districts are shown in Figure A1. Sites were chosen to combine relative proximity to urban centres with access to remote mountain pastures. In Kazakhstan, the sample was drawn from livestock producing areas of Almaty region – including eastern areas of Enbekshikazakh district and the whole of Raiymbek district.<sup>24</sup> These areas are relatively close to Almaty but also highly pastoral, with little or poor quality arable land. In Kyrgyzstan, Jail, Panfilov and Moskov districts in Chui region were selected, including arable areas in the lowlands and high pastures in the Tien Shan Mountains. In Uzbekistan the survey was conducted in Chirokchi and Yakkabogh districts of Kashkadarya region, close to both mountain pastures and to the markets of Shahri-sabz and the more distant Samarkand.

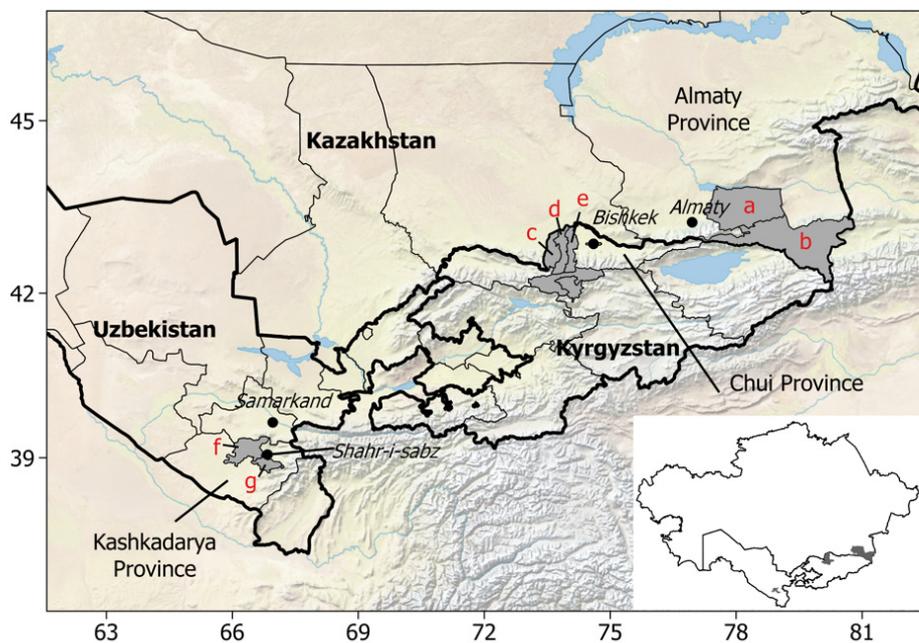


Figure A1 Map of study sites

Notes to map. District names: (a) Enbekshikazakh; (b) Raiymbek; (c) Panfilov; (d) Jail; (e) Moskov; (f) Chirokchi; (g) Yakkabogh. At the Kyrgyz sites, polygons in grey south of named districts constitute pasture areas allocated to those districts.

### Sampling

**Kyrgyzstan.** The three selected districts were comprised of between five and twelve sub-districts each. Lists of all households and farmers having cattle in each of these sub-districts were

<sup>24</sup> Since 2018 this district has been split into Kegen and Raiymbek districts.

compiled from pasture committees, veterinary services or village authorities. The four sub-districts in each district having the most cattle were selected and only those households/farms having a minimum of five cattle in per household were included in the sample frame. The sample was stratified by district to give the same number of respondents - around 83 - in each. The fraction of the sample frame (and probability of being selected) is thus different in each district. In each of the four selected districts in each district, a constant fraction of households was sampled. There was no stratification by household and farm. In reality, the difference between farmers and households is slight and the two groups represent a continuum rather than quantitatively different categories. In the final sample the proportion of self-declared households and farmers turned out to be around 50:50.

**Uzbekistan.** Lists were compiled of all *dekhan*<sup>25</sup> households in the two districts (comprised of 63 sub-districts). At the district level households were selected to ensure that there was no more than 100 and not less than 50 households per district:  $50 < \# < 100$ . At the sub-district level, using the lists, every sixth household was selected up to a total of ten in each sub-district. This resulted in a random sample in which no more than ten households were sampled per sub-district. Thus, smaller sub-districts are over-sampled and the sample is neither a constant proportion nor a constant number per sub-district. Farmers (*fermer*) were represented by two types: those having over 30 animals are 'livestock farms' whilst those having 1–30 head of cattle belong to the 'mixed farm' category. These two farm types were selected from lists obtained from district authorities. Respondents were picked from each list separately, to give a 50:50 split between the livestock and mixed farm category. Concerning the split between districts, not more than 50 and not less than 25 respondents:  $25 < \# < 50$  were selected per farm category in each district. Over the two districts there were a total of 400 livestock farmers on the list. A total of 79 of these were randomly selected out of the entire list, with no stratification for sub-districts. There was a very large number of mixed farmers. The 78 to be sampled were randomly selected across the lists, again with no stratification for sub-districts. Thus farms with livestock specialisation are oversampled. Questionnaires eventually usable for analysis came to 152 households 73 mixed farms and 76 livestock farms.

**Kazakhstan.** Surveyed households and farms were selected through a two stage sampling process, with first sub-district, then farmers and households sampled at random using different methods. Firstly, lists of registered peasant farms (*kristianskoe khozaistvo*) covering the districts of interest were obtained. Fifteen clusters of 13–14 farms were selected over the list of sub-districts using probability according to size based on farm numbers from the list. Two sub-districts were very large and so were represented by two clusters – i.e. 26 farms, reducing the final number of selected sub-districts to 13. The 13–14 farms in each cluster were selected at random from the lists, to bring the total to 200, each with an equal probability of selection. Concerning households, lists were not available so these were selected by visiting three or four houses at random in each cluster to bring the total number of sampled households to 50. In the field, as many of the livestock-owning farms in Enbekshikazakh district could not be found, more than the original selected sample of two sub-districts had to be sampled. Thus a total of 16 sub-districts appear in the final sample, five in Enbekshikazakh and eleven in Raiymbek district.

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<sup>25</sup> Households involved in farming but without the registered status of farmer which would allow them to lease land.

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