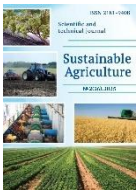
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Agriculture value chain in case of livestock feed sector

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a r t i c l e i n f o

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a b s t r a c t

In the development of livestock farming, along with a number of factors, it is important to provide livestock with sufficient quality feed at different times of the year and expand feed sources. This will increase their productivity, prevent them from contracting various diseases, produce healthy offspring, increase the income of participants throughout the value chain, and ultimately provide end consumers with quality products. This article discusses the results of research conducted on the state of the feed stage of the livestock value chain.

1. INTRODUCTION

Considering one of the key economic subsectors Uzbekistan's economy, livestock constitutes 15.5 percent of the GDP and about 50.8 percent (livestock value added) of the national agricultural GDP. Livestock is considered one of the main sources of the rural households' income and plays a significant role for food and nutrition security. Livestock farming is also considered an important source of self-employment for the rural population, especially for rural women. In 2019, the number of people employed in livestock and livestock derived jobs in Uzbekistan is 420 thousand where it is expected to be 706.0 thousand units in 2030 (Khujabekov et al., 2023). Dairy (cattle), meat (cattle, small ruminants, poultry, and fish), and egg (poultry) are the most important livestock value chains (Romagnoli et al., 2022). According to the results of 2024, peasant and private households have the highest shares in livestock production, in particular, they account for 84.6% of meat, 92.5% of milk, 57.0% of eggs, 81.9% of wool, and 79.3% of karakul leather Most of the livestock is kept in households — 76% of cattle, 78% of goats and sheep, 53% of poultry (Review.uz, 2022).

Despite the reforms carried out in recent years to improve livestock breeding, expand feed resources, ensure animal health, and widely introduce market principles into the sector, a number of problems can be identified that hinder the development of the livestock value chain. In particular, they include: 1) difficulty in accessing financing sources (loans up to 24% and short terms), lack of systematization of the system for combating various diseases (losses and low productivity as a result of the spread of diseases), feed problems (severe degradation of pastures, very limited types of pasture fodder, low cultivation of fodder crops, high prices of processed fodder products), limited processing industry (products such as hides and wool are discarded without processing, destroying potential income), lack of knowledge and skills in livestock farming, etc.. Among these groups of limiting factors, problems related to livestock feed are of leading importance.

Areas planted with forage and feed crops have been reduced by 70% since independence, whereas the cattle population has increased by 150%, reaching 15 million head and leading to a significant increase in GHG emissions (Hoek, 2020). During the years of independence, in order to ensure the country's food security, wheat acreage was expanded, and cotton and wheat were maintained as the main strategic commodities for many years. As a result, the area of fodder crops for livestock decreased, which also negatively affected the development of livestock farming. Although a certain amount of fodder crops were planted in the areas vacated by cotton and grain, late vegetable crops remained the main crop. Delinking livestock from cotton production has led to decreased cotton yields and reduced feed availability. The sector employs about 27 percent of agricultural workers. However, it is the source of over 13 percent of the country's total greenhouse gas emissions (GHG) and most of the agricultural emissions (World Bank, 2023).

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2. LITERATURE REVIEW

Key factors constraining livestock production in Uzbekistan include insufficient feed resources and lack of land area (Hoek, 2020). Feed availability is one of the key issues of livestock rearing in Uzbekistan. Modest sizes of dehkan plots restrain provision of feeds for livestock, which is bred in dehkan households. Only 57% of households supply (even partially) their livestock with feeds produced on their own plots. The majority (75%) of them have to buy feeds (Yu.B. Yusupov et al., 2010). Moreover, 62% of households deals with collecting feeds for their livestock - mow grass, collect food waste etc. Grazing livestock along roadsides and ditches is widespread. Grazing livestock on community pastures, including by hired shepherds, is not common due to a lack of rangelands.

As the population grows, the demand for livestock products, such as meat and dairy products, increases. In order to increase the efficiency of livestock farming, it is very important to increase the material and technical capabilities of farms specializing in the production of livestock feed in the regions. Cattle on the farm showed extra growth of 80.3 kg when fed a regular feed ration and 95.8 kg when fed feed supplemented with feed additives (Toshboev et al., 2024). Cattle diets were mainly based on crop residues (stover, straw) and cattle mortality due to cold stress represents a threat to animal welfare.

A recent USDA report (2011), for example, underlined that insufficient feed resources and lack of land areas and turnover are key factors affecting negatively the livestock sector in Uzbekistan. Nevertheless, the generalization of such bottlenecks on livestock or cattle production is insufficient for shaping and developing policies to improve livestock management, production and productivity (Siegmund-Schultze et al., 2013).

The small farmers, called dekhans, do not have enough space to feed their animals on their own plot of land, usually a half-hectare adjoining their home. Yet, despite limited resources and high levels of poverty, the dekhans provide 90% of the national meat and dairy production (AFD, 2022). Sheep farming is one of the oldest branches of livestock farming in Central Asia including Uzbekistan where the local breed of Karakul sheep is not only a source of Karakul skins, which are its main product, but also serves as a basis for producing meat, wool, and leather products at low costs.

The development of sheep farming is a socio-economic issue and has become one of the priority areas for deepening and advancing economic reforms in the sector (Akhmedov, 2024). Regardless of allocation of 0.30-0.40 hectares of land were allocated for each type of commodity for the fodder base, the monitoring of the land use is not well organized. The structure of the placement of feed crops should be focused on obtaining at least 18-19 tons of feed units per ha by the selection of varieties, by agrotechnical methods, ensuring optimal normalization with organic (20-30 tons) and mineral fertilizers (Dosmukhamedova, 2022).

One of the most serious problems is the shortage of feed is associated with an excessive reduction in the sowing areas (by 70% since 1991) of feed crops. Small-scale livestock farms have limited access to land and face difficulties to supply their animals with seasonal feed in winter when feed prices are high in the market. As per conducted survey results, 43.2% of respondents would like to use more land for pasture land where 93.7% mentioned the lack of pasture land to rent (Khamdamova et al., 2024).

Grazing on public pastures, including by hired herders, is not very common due to a lack of grazing land. High pressure associated with excessive number of livestock grazing, climate change and noncompliance with pasture management are main causes led to a deterioration in the quality of pastures. The main causes of pasture degradation are wind, water erosion, as well as hillside plowing, improper irrigation practices and excessive grazing (Faizullaev, 2022).

3. METHODOLOGY

The study was conducted based on primary field data (quantitative and qualitative) collected through questionnaire among value chain participants and secondary census data in addition to literature review relevant to the livestock value chain. Primary data for the study was collected on the example of different regions of Uzbekistan. Field survey with value chain actors was conducted in Samarkand and Kashkadarya regions. Primary data is collected in value chains including farmers, livestock clusters/LLC, dehkan farms and households. Secondary data sources included National Statistics Committee and Ministry of Agriculture of the Republic of Uzbekistan. Data collection tools are household survey, target group interviews, expert discussions and observations, official annual reports and other relevant publications.

4. RESULTS AND DISCUSSION

Sources of feed of sheep and goat in the sites

In Samarkand and Kashkadarya regions, where the survey was conducted, and in Tashkent, Khorezm regions, and Fergana Valley regions, where sheep value chain experiences were studied, there are certain differences in terms of geographic location, climatic conditions, and sheep rearing practices. In general, due to a number of other similar factors, the sources of fodder for sheep are different in the regions of Uzbekistan.

Dependence of small ruminant feeds on different sources in the regions

Regions	Desert Pasture	Mountain Pasture	Own feed crops	Purchased wholesale	Retail market	Grazing in edges of ditch, field	SR share in total country
Kashkadarya	High	Very high	Medium	Low	High	High	20.8%
Samarkand	High	High	High	High	Medium	Medium	11.0%
Surkhandarya	High	Very high	High	Medium	Medium	High	10.7%
Bukhara	very high	Very Low	Medium	High	Low	Low	10.2%
Navoi	very high	Very high	Very low	Low	Medium	High	10.1%
Jizzakh	High	Very high	Very high	Very high	High	Low	9.8%
Andijan	Not exist	Very low	Very low	Very high	High	Very low	6.5%
Karakalpak	very high	Not exist	Low	High	High	Medium	5.1%
Tashkent	Low	High	High	High	Medium	Low	4.7%
Fergana	Not exist	Medium	Very low	Very high	High	Very low	3.9%
Namangan	Not exist	Low	Very low	Very high	High	Very low	3.5%
Khorezm	very high	Not exist	High	Medium	Medium	Medium	2.1%
Syrdarya	very high	Not exist	High	High	Medium	Medium	1.6%

N/E-not exist; SR-small ruminants; Source: Author's observation

In the survey areas, shepherds graze sheep mainly in pastures from early spring to mid-autumn. In winter sheep herders use hay and other types of fodder collected during the summer. In order to ensure the health of the sheep during the cold days of winter, they are also fed with additional concentrate feeds. Big farms use grain from from their own farming while small-scale herders mainly purchase feed and grains from local feed market.

Cotton seed husk, cotton seed hulls obtained from cotton cleaning and processing plants are used as fodder for sheep. Also, cottonseed meal, sunflower meal, sesame/flax meal, peanut husks and other types of wastes from grain mills are used as additional ingredients for small ruminant feed.



Hay storage (hay shed) in a sheep farm, Kashkadarya region



Camel's thorn hay storage (open air) in dehkan farm, Samarkand region



Storing hay in a sheep shed at an agribusiness enterprise, Samarkand region



Hay storage covered with plastic foil in household, Kashkadarya region

Hay storage of sheep herders in the surveyed regions. ***(©Photo/Sirojiddin Eshmatov)***

Fodder types and their characteristics

All types of fodder for sheep are mainly divided into three groups (Agro-Olam.Uz, 2021): i) feed made from plant products; ii) feed products made from animals; iii) mineral substances. Feed from plant products are:

1. Green grasses- natural pasture grasses, hayfields, planted grasses and others
2. Course/Roughage (feed)- hay, straw, grain extracted corn stalk
3. Roots- beets and turnips
4. Ensiled feed- silage
5. Multi grain mixed feeds- grains and seeds
6. Technical production waste- waste (feed) from flour industry, sugar factories, fruit/vegetable processing, and oil production enterprises).

Feed from animals include bone meal, fish meal where Mineral substances include different chemical additives and vitamins.

Green fodder. All types of plants grown naturally and artificially are considered green fodder. For example, various grasses, legumes (barley, oats, wheat) and leguminous plants (alfalfa, chickpeas, beans), stems and leaves of root vegetables are among them. These types of fodder are mainly fed to sheep in spring, summer and autumn. They are valuable because they contain a lot of substances such as water, protein, carotene, vitamins (A, D, E, C). These have a positive effect on the growth, development, fattening and productivity of animals.

In rural areas, alfalfa and corn are grown as traditional green fodder crops in households, dehkan farms and farms, while grasses are mostly harvested between trees, canal edges and rows of various vegetables. Alfalfa and corn are mainly selected and propagated by sowing seeds. In order for them to grow well, special attention and agrotechnical measures are carried out.



Alfalfa



Grass



Corn

Roughage (rough feed) consists mainly of hay, straw and stalks of various plants (corn, cotton stalks, sorghum, sunflower and sorghum). They are widely used in livestock feeding in all regions of our country.





Local livestock feed market in Tashkent region

There are local livestock markets in various parts of the country, and not far from them there will also be livestock feed markets. There, farms and farmers sell the roughage they collect from their land in truckloads. Such feeds are also sold by middlemen involved in the sale of feeds. They buy the roughage from the farmers and sell it with a certain margin. Or they themselves buy coarse feed from the farmers' fields on the basis of an agreement, load it on a truck and sell it to buyers in the market.

Hay is the most used of all types of roughage. In Uzbekistag, alfalfa hay is especially important feed for horse, sheep and cattle. Its chemical composition depends on the agrotechnical measures used in the cultivation of alfalfa, harvesting during flowering, drying and storage technology. Hay is made from the stems of all other types of plants. The chemical composition of hay varies according to its quality. For example, its composition consists of 4-26% protein, 3-7% fat, 20-35% fiber, 28-39% nitrogen-free extractives, 3-11% dust. 1 kg of quality alfalfa hay can contain up to 0.5 kg of nutrients. In addition to alfalfa, hay made from a mixture of various summer grasses, peanut hay, mosh hay, corn hay, etc. is made and fed to sheep in winter and spring.



Alfalfa bale, 20 kg
$2.9/per bale
©Photo /Sirojiddin Eshmatov



Summer hay, 15 kg
$2.0/per bale
©Photo/Sirojiddin Eshmatov



Peanut hay bale, 15 kg
$2.0/per bale
©Photo/Sirojiddin Eshmatov

These hays are mainly stored in covered buildings in a compressed form as shown in the picture, protected from precipitation. They are easy to transport, stack, and feed to sheep, and they don't require a lot of storage space. Because it is expensive to buy bales, households, dehkan farms and small farmers cut autumn weeds on the edges of the fields, in the gardens and collect harvest leftovers and store them for the winter feeding of the sheep and goats.

In addition, in different regions of the republic, shepherds harvest the Alhagi plant, which blooms well at the end of the summer months. Then the Alhagi is dried in the field into bales weighing 15-20 kg, and the collected bales are delivered to the place where the sheep are kept for the winter. Among the roughages, sorghum is of particular importance and contains 0.44 percent of nutrients per kilogram in its green-wet form. However, the population does not pay attention to the strength of Alhagi fodder and the fact that it grows in wide pastures, they buy straw or alfalfa from the market at an expensive price and raise sheep at home.



Autumn hay (mixed), 15 kg
$2.3/per bale
©Photo /Sirojiddin Eshmatov



Alhagi bale, 15-20 kg
$1.6/per bale
©Photo/Sirojiddin Eshmatov

Alhagi bales are stacked 3-4 meters high in rectangular or circular shape in open air (outside) and its top is covered with wood or tin. Due to its open sides, Alhagi attracts moisture and becomes relatively softer in rainy and cold weather. Since Alhagi grain is harvested when ripe, its

red ripe grains are a useful forage that is good for sheep and goats to eat. Straw is different from other types of plants. For example, autumn rye straw contains 35-45 percent fiber, wheat straw contains 10-20 kg of nutritional units and 0.3 kg of digestible protein per 100 kg. 4-5% of protein is contained in the straw of grain plants, 6-7% in the straw of leguminous plants. It also contains a small amount of carotene, calcium and phosphorus. Therefore, the nutritional value of straw is low, and it is relatively difficult to digest it.





Straw bale. 158 bales weighing 20 kg each, wholesale price is UZS 20,000.0 ($1.61) per bale.

Straw is usually formed from the stalks of wheat and barley after they are harvested in the summer. In the combine, the harvested straw is pressed and made into a shape convenient for transportation and stacking. In the regions, straw is one of the cheapest types of roughage and is used the most in the winter months. It is given from the first days of winter to early spring, until the first grasses grow. It can be fed as feed alone or mixed with the porridge of grain crops and oil crops (cotton, soy, flax)

Liquid content feeds. They mainly include root crops, potatoes, legumes, silage, haylage, beetroot and green grass. Without the green grass, the wet feed is low in protein and minerals. Among them, potato tuber is the most nutritious. Because 1 kg of potato nodule is equivalent to 0.3 kg of nutritional unit. If chopped tubers (diameter 3 cm) are mixed with fodder or chopped hay, haylage, straw then animals will eat them with appetite and feed waste will be less.

Fortified (concentrate) feed. Chemically enriched feed is extremely nutritious and rich in various substances. The feed is low in water and fiber. Plant grain and grain processing wastes are also included in feed. The nutritional value of 1 kg of feed is equal to 1 nutritional unit, sometimes even more. In the conditions of Uzbekistan, barley, corn and sorghum feed is used for sheep. The fodder contains a lot of phosphorus and little calcium, and 1 kg of fodder contains 78-80 g of protein. Although the content of bran is second only to whole grain, it is rich in protein and phosphorus.



Mix concentrate feeds in local market
©Photo/Sirojiddin Eshmatov



Feeding with concentrate feed
©Photo/Sirojiddin Eshmatov

Millcake and powdered millcake are valuable for cattle and sheep due to their high protein content (300-370 g per 1 kg) and their nutritional value. Millcake keeps animals full, increases the creaminess of cows' milk. However, it contains a small amount of a harmful substance called gossypol. Therefore, it is harmful to give large quantities of milcake to cattle without any other ingredients. When using concentrate feeds, it is useful to give them to cattle as mixed feed.



Preparing feed with powdered millcake
©Photo/Sirojiddin Eshmatov



Cottonseed meal in local feed market
©Photo/Sirojiddin Eshmatov

Preliminary feed processing. Animal feed (cereals) is first processed to a certain extent. Because if the grain is given whole, it will not be well digested due to the rough shell. That's why it's good to grind them and grind them into cereal or grind them into flour and feed them to sheep. Feed made from different grains (wheat, corn, barley, oats, etc.) or groats cannot be stored for a long time. Especially in the summer months, they

become sour quickly, and if they are kept in a damp place, they get moldy. Therefore, they should be prepared a few days before giving to sheep. If feed, flour and bran mixed with ground hay and liquid feed are given to sheep, their nutritional value and digestibility, as well as their appetite, will increase.

Silage is made from freshly harvested or dried, crushed plant mass. 10-20% of chopped straw is added to silage mass with a moisture content of more than 75%. The goal of making silage is to conserve the digestible fiber, protein, and energy in the forage, to preserve forage nutrients for feeding at a later date and to maintain the protein in a form that can be utilized efficiently by the ruminant animal. This is accomplished by the conversion (by fermentation) of plant sugars to organic acids. Well fermented silages result in reduced dry matter losses, in more feed being available for feeding dairy cows and small ruminants.



The cost of combine harvesting of 1 ha of land is 1.0 mln UZS ($81.0). 70-80 tons of green mass is obtained for silage from 1 ha. The price of selling 1 trailer (4.5 tons) of green mass is 1,5 mln UZS ($121.0).
©Photo/Sirojiddin Eshmatov

The process of reaping corn for silage.

Dehkan farms and households prepare silage in a pit dug in the form of a pond or on flat ground. In addition, to avoid excessive costs or if there is a narrow space, they can prepare silage in various plastic bags 1.5-3.0 meters high. They grow the green mass plants for silage themselves or buy it from farmers. However, in many households, there is a lack of experience in knowing the plants suitable for making silage and planning the time of harvesting them, preparing the conditions for ensiling, making sure that the grass to be ensiled is wet or dry enough, and using it properly after opening the silage.



Making silage in local condition for small scale. The corn in this picture is late to harvest, has low moisture and is cut larger than the recommended size, and the kernels are not fully ground.
©Photo/Sirojiddin Eshmatov



20 kg bag corn silage in local feed market. Salted and buried in a patch for 1 month. Price: 18,000 UZS ($1.5)/per bag.
©Photo/Sirojiddin Eshmatov

Large farmers and feed wholesalers dig large special silo trenches. These silo trenches can be 1.5 thousand to 5.0 thousand tons and even bigger. They press a large amount of green mass using special vehicles and prepare high-quality silage. In order to reduce transport costs and distribution time, farmers dig silo trenches close to livestock buildings. The bottom and walls of the trenches are covered with concrete, and the top of the pressed silage is covered with plastic covers and soil. After 30 days, the silage can be fed to livestock.



Silage prepared in a 2-meter-high plastic bag in a household. The price of 1 plastic bag is UZS 12,000 (0.94 USD)



The process of preparing alfalfa silage in a large trench in a farm field. Alfalfa is grown in the farmer's own field and prepared for the farmer's own livestock or selling to customers.

Silage is also mainly made in local conditions using crops such as alfalfa, sunflower, and sorghum. The more sugar content in the plant, the easier it is ensiled. Among succulent feeds, grass silage is nutritious, with a protein content close to that of green grass.

It is advisable to prepare silage by crushing it depending on the moisture content of the plant to be ensiled:

- If the humidity is 60-70%, then into 2 cm pieces
- If the humidity is 75-80%, cut into 4-5 cm pieces
- If the humidity is more than 80%, cut into 8-12 cm pieces

Preparation of silage by crushing it in these forms serves to its good compaction, reduction of excess oxygen, as well as its high-quality preparation. When making silage, it is recommended that the moisture content of the plant be between 70-75%. If the moisture content is higher than that, 10-20% of crushed straw is added to it, if the moisture content is less than the norm, juicy liquid feed is added. When ensiled in high humidity conditions, the probability of rotting is high, because at high humidity bacteria thrive and this leads to rotting. To prepare high-quality silage, it is important to properly organize harvesting and harvesting of the mass in the most optimal terms. Blue grass for silage should be harvested in such a way that on the day it is harvested, it should be pressed into the silage, otherwise the grass will lose its nutritional value, the silage will deteriorate, and if it is left for a long time, it will become unsuitable for silage due to the loss of moisture. Making fodder from corn stalks, leaves and stalks is of great importance. When the moisture content of the stalks and leaves of the harvested corn for grain is 65-70%, it is considered acceptable to ensilage it in its pure form. If the humidity is reduced to 40-50%, it is necessary to make ensilage in a mixture (1:1) with watery and juicy feed - pumpkin, watermelon, beet pulp, beet leaves, vegetable waste. In Uzbekistan, farmers usually open the silage after 30 days and start feeding it to animals. In the silage, all the components of the plant - leaves, stems, inflorescences should be clearly visible, there should be no crushed slime, rotten mold and other odors. Silage mixed with moldy or rotten plants is not recommended and is harmful to sheep. If a bale of silage is discolored when compressed by hand, and no plant parts are visible, the silage is considered spoiled.

Hydroponics (greenfeed) feeding. Due to factors such as climate change, limited water resources, lack of fodder base for sheep and goats, low quality of fodder, dwindling pastures, high prices of fodder, hydroponics, which is environmentally safe, high-quality, cheap and resource-efficient fodder cultivation, is increasing. Sheep and goat breeders are also very interested in it.

Greenfeed is produced in five to eight days following the following five steps:

1. Wheat seeds are washed
2. Humid seeds are stored in closed barrels for one to two days
3. Seeds are placed on trays in the hydroponic room
4. Seeds are irrigated every three hours by means of a rain irrigation.



Greenfeed growing in hydroponic method (©Photo/Sirojiddin Eshmatov)

Groundwater is used which is low cost with no supply shortage. The use of groundwater is also important to ensure stable water quality in areas where surface water is often saline. One of the surveyed farmers grows feed for 5 days (outturn of 4 kg of feed from 1 kg of wheat) while the other does for 8 days (outturn of 5.6 kg of feed from 1 kg of wheat).

5. Once fully grown, green feed is cut in small pieces (mixed with wheat bran) and fed to sheep and goats. Sheep herders mention that greenfeed has a high caloric content per feed unit and increases animal productivity.



Preparing the grown green fodder for sheep. (©Photo/Sirojiddin Eshmatov)

Demand for greenfeed is high and has potential to grow when the product becomes more known. Livestock farms and fish farms located in the regions of Uzbekistan are the main potential buyers of greenfeed. Some product preferences are already shaping-up with livestock farms interested in purchasing 5-day grown greenfeed (high energy content) while fish farms are interested in purchasing 8-day grown feed (high biomass). Local farmers traditionally feed their livestock with fresh and dried alfalfa, corn stalks and silage, wheat straw, corn and wheat bran. However, there are limiting factors to the production of these feed, such as the availability of productive land, high water demand for alfalfa and corn cultivation, high cost and time required for harvesting, drying, transportation and storage, low nutrient (e.g., in wheat straw). In this context, hydroponic green feed is an interesting substitute which can be produced in large quantities without using a lot of resources.

Cost comparison of green feed and traditional feeds

	Green feed*	Wheat bran	Corn bran	Dried alfalfa hay**	Wheat straw***
Cost (UZS/ton)	2,000,000 ($162)	3,200,000 ($260)	3,800 000 ($310)	2,400,000 ($195)	1,500,000 ($122)
Daily consumption per sheep, kg	3.0	2.5	2.5	7.0	7.0
Daily cost per sheep, UZS	6,000 ($0.48)	8,000 ($0.65)	9,500 ($0.78)	16,800 ($1.36)	10,500 ($0.85)
Digestibility	High	Good	Good	Medium	Low
Productivity (weight gain/day)****	High	High	High	Medium	Very Low

** Selling price; **One bale of dried alfalfa is 15 kg and price is UZS 35,000.0 /bale.*

****Average weight of one bale of wheat straw is 10 kg and rice is UZS 18,000.0/bale.*

*****based on survey data and interviews with key informants*

Source: survey field data

Since the technology of greenfeed preparation by hydroponics method is innovative, it is appropriate to organize trainings for increasing the capacity of farmers, dehkan farmers as well as households.

Granule (pills) feed feed has a number of advantages in sheep feeding, including: uniform distribution of various feed raw materials and additives (vitamins) in the feed, reduction of feed waste by spilling from feed containers, convenience of feed for sheep consumption, ease of transportation and distribution of feed, granule lack of storage space for feed, etc. The composition of pellet feed for sheep raised for meat production can be different. It depends on the availability, price, quality of raw materials used in the preparation of fodder, for what purpose the sheep are fed, the age and sex of the sheep and other factors. The main goal is to produce feed with high nutritional content and low cost. Sheep granule feed ration may include: corn 30%, wheat 20%, different vitamins 0.5% (1 kg of vitamin costs USD 3.0) and remaining other ingredients . Also, some sheep breeders prepare special vegetable pellets for the healthy growth of lambs, taking into account the condition of young lambs in consuming and digesting solid feed. These feeds stimulate the appetite of the lambs and are also very useful. The average production cost of pellet feed is UZS 2,100.0-2,200.0 (USD 0.17). However, adding their margin, feed producers sell feed to other buyers for 1 kg UZS 4,500.0 (USD 0.36). It is enough to give 700 grams of pellet feed 2 times a day (morning and evening) to 1 sheep raised for meat. In addition, it is necessary to graze the sheep in the pasture or, if they are kept in a sheepfold, give them dried hay. Before preparing granule feed, it is necessary to thoroughly clean the contents of the fat ingredients from flowers, pods, various stones and unnecessary objects to avoid feed quality decrease and feed making machine damage.



Pellet feed for sheep fed for meat



Carrot, red beet, pumpkin mixed granule feed for young lambs

Granule feed for sheep and lamb. (©Photo/Sirojiddin Eshmatov)

Fodder manufacturers formulate the composition of this type of fodder based on their experience. The remainder of this feed is sold to buyers in the local market. The market price of 1 kg of pellet feed is around UZS 4,000.0-6,000.0 (USD 0.35-0.47), depending on the feed composition and regions. In addition, pellet feed manufacturers can change the feed composition according to customer requirements. In addition, buyers bring their own raw materials and pay 30.0 UZS to produce 1 kg of feed. Many feed manufacturers have also introduced free delivery services to customers to increase their competitiveness. Pellet feed is more demanding for sheep farmers in urban conditions because it does not create dust during loading and unloading, storage and feeding to sheep.

The success story of surveyed sheep herder who raising sheep for meat

Internal and external parasites in sheep consume 30%-40% of the feed given to sheep. Due to the fact that sheep do not absorb the given feed well, the cost of feed increases and their fattening is slow. If good cleanliness is maintained, sheep absorb 80%-90% of the feed they consume and profitability increases. While treatment with special drugs against liver and intestinal worms is considered to rid the sheep of internal parasites, shearing and bathing the sheep rids the sheep of external parasites.
Including feed and other costs, the daily cost per sheep is UZS 6,000 (USD 0.47).

Sheep raised for meat production must first be gutted and trained to consume more feed. Feeding large amounts of feed at once to fed young sheep will cause them to choke and lose their appetite. If they are gradually trained to eat more concentrates and green forages, they will gain weight faster and their appetites will be balanced. For example, to a newly purchased sheep with a live weight of 40 kg for meat feeding: 3 times 250 grams of bran every 8 hours for the 1st 10 days; 250 grams every 6 hours in the 2nd 10 days. Later, it is possible to fill the sheep's feeder with fodder and switch to continuous feeding mode. As sheep get fatter, they begin to eat less feed (their stomachs get smaller). This method ensures that they fatten evenly and quickly, reduces various costs and accelerates the time of sending to slaughter.

List of the requirements and availability of coarse and green feed for farms that specialized in breeding livestock, thous.tons

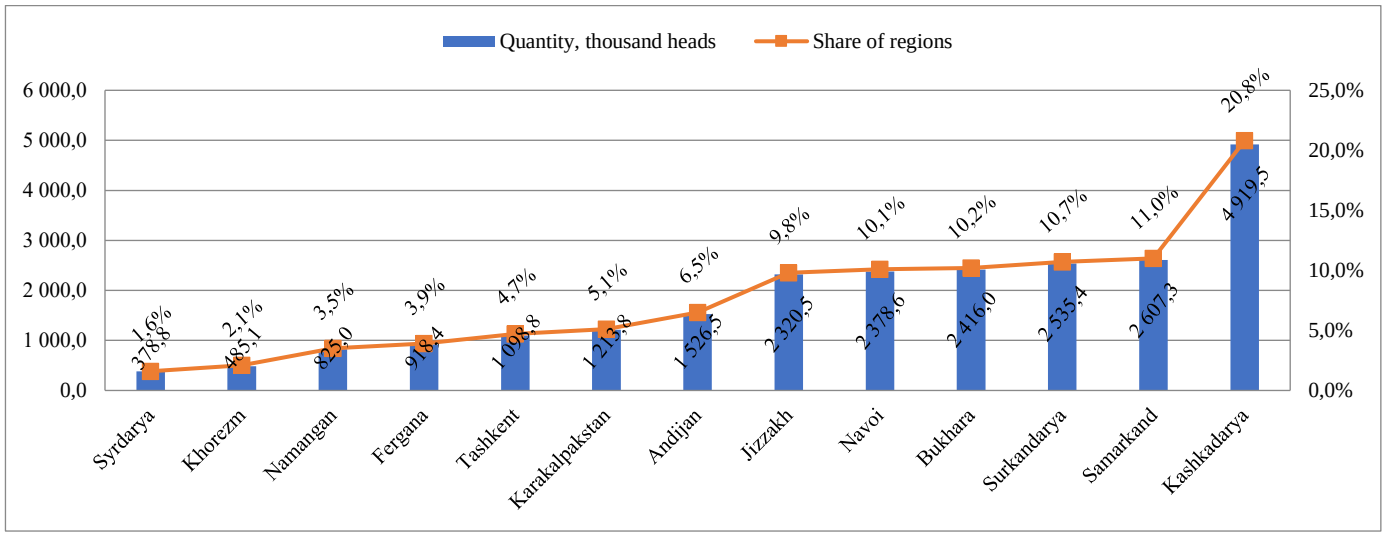
Feed types	**Demand, target**	**Actual**	**Coverage %**
Hay	515.0	350.9	68%
Straw	487.0	1491.2	306%
Senage	695.0	389.5	56%
Silage	949.0	580.9	64%
Beet	228.0	0.3	0.15%
Green mass	3937.2	1594.5	47%
Total feed	**6607.2**	**4491.0**	**67%**

Source: Adopted from Toshboev et al., 2024

Small ruminants changing tendency

The total number of sheep and goats in the republic as of January 1, 2023 reached 23 623.7 thousand heads. Compared to the corresponding period of 2022, in all categories of farms, their livestock increased by 653.4 thousand heads (by 2.8%).

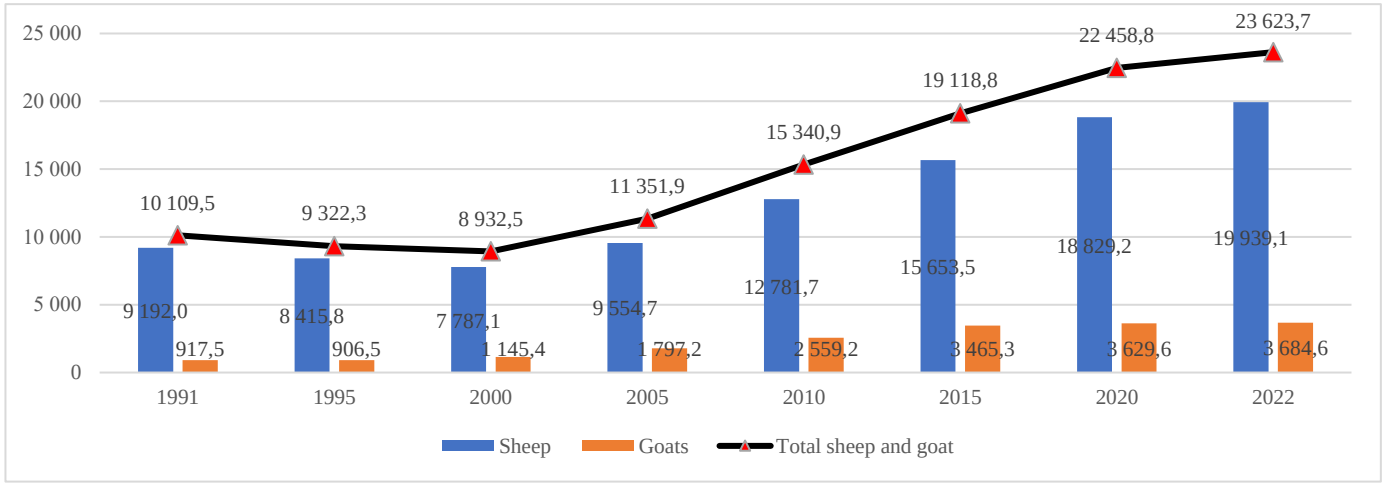
An analysis by category of farms showed that 14.8% of the total number of sheep and goats fall on farms, 78.5% - on dehkan and subsidiary farms, 6.7% - on organizations engaged in agricultural activities. Kashkadarya and Samarkand regions are leading while Sirdarya and Khorezm regions last areas as per number of sheep and goat available.



Number of sheep and goats by region in 2022

Source: Developed as per data of Statistics Agency of Uzbekistan, 2023

Number of sheep reached to 18,829.2 thousand pcs by the end of 2020 while it was 9,192.0 thousand pcs in 1991 and growth rate was 105.0%. Number of goats also increased and reached to 6,629.3 thousand pcs in 2020 compare to 917.5 thousand pcs in 1991 with growth rate of 296%.

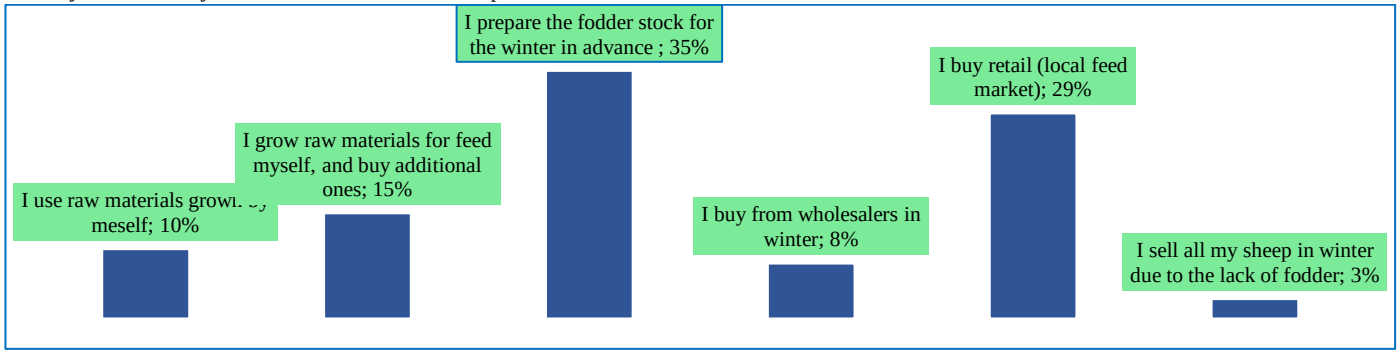


Number of sheep and goat in the Republic of Uzbekistan in 1991-2020, thousand heads

Source: Developed as per data from https://data.egov.uz

Availability/Scarcity of feed over seasons

One of the biggest problems of sheep herders in Uzbekistan is the shortage of fodder. This shortage is caused by a number of factors. Seasonally, from late fall to early spring, sheep breeders experience the most difficult forage supply period. As mentioned above, if farms with large arable areas reserve their fodder crops for the winter months in the form of hay or grain, farmers and households are forced to buy fodder at a high price during the winter months. In rural areas, winter feed stocks are mostly purchased from farmers and wholesalers, while in urban areas, this task is mostly done by retailers in local feed markets. Respondents who took part in the survey stated that there is a severe shortage of fodder in the winter months, but they said that they cover the demand for fodder products from various sources.



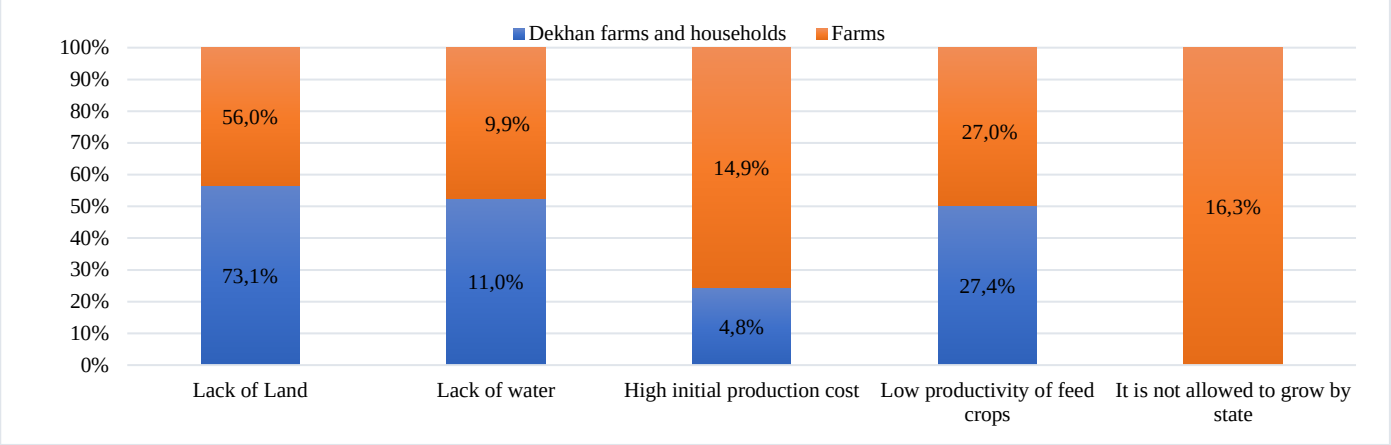
Supply of fodder for sheep herders in winter months

Source: Survey data

Most of the sheep herders (35%) stock feed and raw materials for the winter months in advance. Such an approach allows to save a certain amount of financial resources due to the purchase of more products at a cheaper time in the summer and autumn months before the winter. Also, buying in advance ensures quality products and avoids the risk of food becoming unavailable during the winter months. A certain number of sheep herders (3%) sell their sheep in winter due to the lack of warm indoor sheep houses to keep sheep in winter months, lack of fodder stock, lack of funds to care for sheep and the need of people to improve their family supply in winter.

From early spring, when grass grows in pastures, fields, and at the edges of ditches, sheep are fed in these places. Crops are planted in farm fields and household plots from early spring, and the weeds removed from the crops serve as fodder for small ruminants. Different fodder crops are planted between the rows of fruit trees in the gardens. In place of wheat and barley harvested in the summer, corn, sunflower, peanuts, mush, beans, carrots, turnips, beets, radishes, alfalfa and other types of crops are planted as second crops. After they are harvested, their stalks and crops are fed to small ruminants and a certain part is reserved for the winter months.

During the survey, it was found that only 10% of sheep herders (mainly farms and dehkan farms) grow plants that they use for feed preparation and stocking for winter on their land. The survey did not explore the factors preventing this in depth. On the contrary, the reasons for this have been thoroughly studied in literature review.

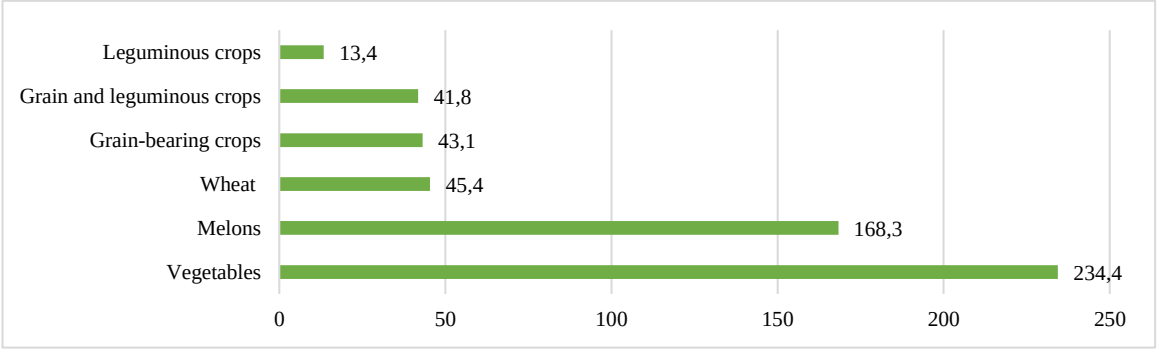


Reasons restraining dehkans, households and farms in producing feed crops

Source: adopted from Yusupov et al, 2010.

Dehkan farms and households suffer from insufficiency of feeds for the sheep production because of lack of land and low feed crop productivity. As a result of water scarcity, the cultivation of food crops is becoming a problem, and the installation of water-saving technologies is expensive for small-scale farms and dehkan farms. Another factor is administrative restrictions which farmers and dehkan farms are not allowed to choose types of crops to cultivate, which are actually pushed out with cotton, wheat and fruits and vegetables. Gross harvest of main feed crops including barley and corn are not increasing because of above mentioned factors in Uzbekistan. Cotton meal, wheat bran, low-quality or non-edible vegetables are also used as fodder for sheep, and certain increases are observed in the cultivation of these products.

Barley is mainly grown in dryland and is grown mainly due to winter and spring rainfall. However, due to climate change in recent years, there is less rainfall and this has a negative impact on barley farmers. Similarly, the gross harvest of maize, one of the main ingredients in sheep feed, is affected due to lack of water, machinery, quality seeds, mineral fertilizers, pesticides and various diseases. In 2021, the productivity of grain and leguminous crops, which are widely used in the cultivation of livestock feed, was 4.2 tons per hectare, while that of wheat was equal to 4.5 tons per hectare.

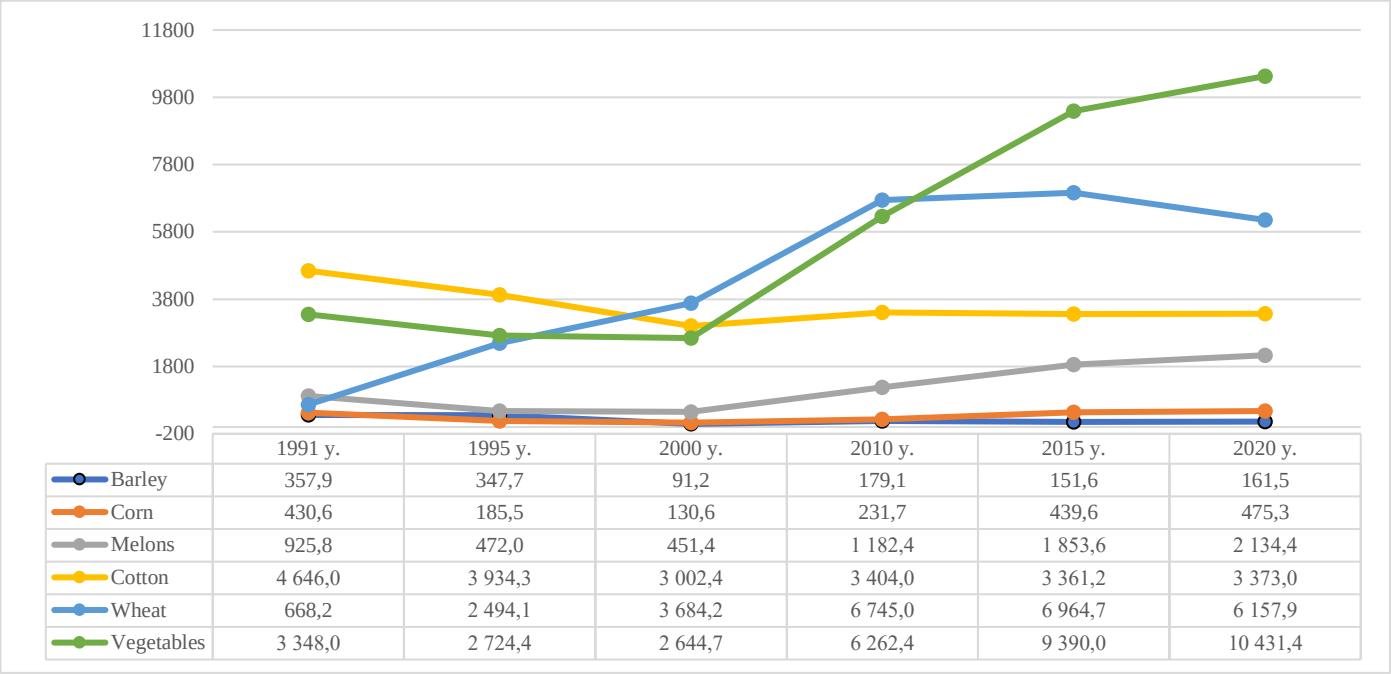


Productivity of selected crops in 2023, in centner*

**Centner equals to 100 kg*

Source: collected from https://data.egov.uz

If we look at the trends over the past 30 years, we can see that with the growth of the population in the country, the main focus has been on ensuring food security, in particular on the volume of crops such as fruits and vegetables, melons, and grains. As a result of the reduction in the area of crops planted for livestock feed, feed supply has decreased. On the contrary, the number of livestock has steadily increased.

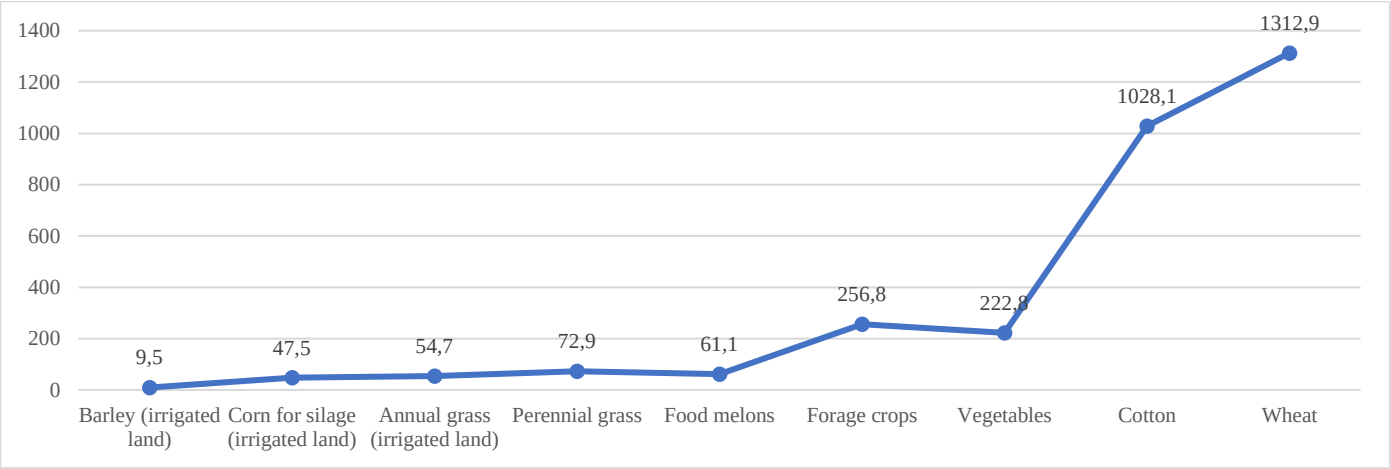


	1991 y.	1995 y.	2000 y.	2010 y.	2015 y.	2020 y.
Barley	357,9	347,7	91,2	179,1	151,6	161,5
Corn	430,6	185,5	130,6	231,7	439,6	475,3
Melons	925,8	472,0	451,4	1 182,4	1 853,6	2 134,4
Cotton	4 646,0	3 934,3	3 002,4	3 404,0	3 361,2	3 373,0
Wheat	668,2	2 494,1	3 684,2	6 745,0	6 964,7	6 157,9
Vegetables	3 348,0	2 724,4	2 644,7	6 262,4	9 390,0	10 431,4

Gross harvest of Barley and Corn in Uzbekistan in 1991-2020, in thous. tons

Source: developed based on data from https://data.egov.uz

Cotton and grain, as well as fruits and vegetables are the main crops, and they have a major share in the total agricultural crop area. In recent years, the practice of planting fruits and vegetables in areas with low productivity of cotton and grain has been expanding. Low productivity means less income for farmers and more water is used for cotton and wheat. Instead, in order to ensure the country's food security, specialized areas are being established to grow fruits and vegetables that require relatively little cost and can be exported. The adoption of water-saving technologies is increasing.



Sown area of different crops in Uzbekistan in 2023, in thousand tons

Source: collected from https://data.egov.uz

The development of sheep and goat breeding, increasing the efficiency of the sector, and increasing incomes among the herders in the value chain are faced with difficulties due to the influence of a number of factors. During our research, the main factors affecting the development of sheep farming, which were most emphasized by experts, researchers and practitioners, were feed products, lack of pastures, financial opportunities and limited land resources.

The main problems hindering the development of the sheep value chain in Uzbekistan are explained by the low level of economic growth and low profitability of the sector at the national level. The main problems in the sector of sheep products appear as problems in the production of sheep products, their processing, and the production of value-added products. National and sector-level problems are in turn caused by the most important key issues. This set of problems includes limited production capacity, lack of processing and marketing, financing and land tenure constraints.

Grazing in pasture

In Uzbekistan, from early spring, large sheep farms, peasant farms and most households send their sheep to pastures in the mountain and desert regions for a certain fee. Sheep are very hardy and mobile, able to cover long distances (up to 50 km per day) and make good use of pasture plants in lowlands, deserts, semi-deserts, mountains and highlands. They differ from other agricultural animals due to the proportionality of the head surface, strong teeth and low mobility of the lips, they eat low-growing plants, dry stems, grasses, and even find food for themselves in pastures with low productivity. These characteristics of sheep are of great

practical value, mainly because they increase the efficiency of using land that is not suitable for agricultural crops or where there is no possibility to feed other types of agricultural animals.

Winter grazing. We mentioned above that feeding sheep in sufficient quantity and quality in the winter season is one of the main difficulties faced by sheep herders. For this reason, shepherds try to graze their sheep in the winter months (December-mid February) in the fields of farmers, pastures , orchards, on the edges of ditches and similar places where sheep can feed, which are located not far from the sheep sheds. They also use the pastures belonging to the clusters on a lease basis, graze their sheep on the edges of ditches and in various other areas.



Farm field in winter



Winter grazing in cluster pasture



Winter grazing in farm pasture

Winter grazing in the pasture. (©Photo/Sirojiddin Eshmatov)

When grazing in the pasture in winter, the temperature of the air, the amount of precipitation, the condition of the sheep (health, lambing, etc.), the condition of the pasture, how far it is from the sheep houses, what time of the day it is, and other factors are taken into account. The main focus is on preventing negative effects on the health of sheep, preventing new-born and young lambs from catching a cold in rainy and windy weather.



Grazing in cold snowy weather



Muddy pasture after heavy rain



Deser pasture plants under the snow

Winter grazing in the pasture. (©Photo/Sirojiddin Eshmatov)

After heavy rains during the cold winter days, water accumulates in desert pastures, making it difficult for sheep to move, especially young lambs and pregnant ewes. Also, while picking plants from under the snow, they eat them along with snow and frozen soil. As a result, the health of sheep may be affected.

Summer grazing

As soon as spring begins and the days get warmer, farmers and households send their sheep to summer pastures. In the conditions of Uzbekistan, depending on the region, the summer grazing period includes the months of March-November. In mountainous and desert areas, sheep are returned to their owners from the pastures before the onset of snow and cold precipitation. By this time, the grass consumed by the sheep in the pastures is almost exhausted, and if the sheep are not returned and fed with additional feed, they can quickly lose weight and suffer from various diseases. Transporting sheep to distant pastures and bringing them back is done by vehicles.

The payment for the use of pastures is generally considered more expensive for dehkan farms and households. This is explained by the small number of sheep in them. Large farmers with more than 400 sheep may pay less on a wholesale basis, but they send sheep to pastures in different regions, and transport costs are more expensive. Since the clusters own their pastures, they do not pay any fees, they only pay land tax for the area occupied by the pastures they use. Therefore, the clusters allow farmers, dehkan farms and households to graze sheep on their pastures for a certain fee to cover a certain part of their costs.

Grazing Distance of households and dehkan farms in local territory. The grazing distance of 1 sheep depends on the type of pasture, its location and the limits set by the shepherds themselves. During the survey, for example, households and dehkan farmers graze their small ruminants in fields belonging to large farmers, on the edges of ditches and crop fields and similar areas not far from their homes, within an average radius of 1-5 km. 1 sheep can walk up to 3 km for daily grazing. In the summer and autumn months, they can graze their sheep in the farm fields where various agricultural crops have been harvested. These can be mainly grain, cotton, corn, alfalfa, vegetable fields. There is usually no charge for such grazing, and it is a mutual agreement that the sheep do not damage crops and garden trees. Farmers can receive a fee only in certain cases.

Grazing distance in long range pastures.

Sheep grazed on pastures in mountain and desert areas can graze 8-10 km in 1 day. The size of these pastures, the large number of sheep, the condition of the green mass in the pastures, certain requirements for the preservation of pastures and other factors are the reason for this arrangement.

A farmer who rents a pasture at a distance of up to 400 km (from Samarkand-Almaliq district to Tashkent region) pays 30,000.0 UZS for 1 sheep to transport to take sheep to the pasture and bring them back. Trucks of various types are usually used to transport sheep over this distance.

Payment for grazing. Farms hire shepherds to graze their sheep on leased pastures and pay 3,000.0 UZS per month per sheep. Pasture rent farmers pay 110,000.0 UZS per year for 1 sheep (grazing period for 9 months). Households and dehkan farms (with a small number of sheep) pay 15,000.0 UZS per month for pasture rent per sheep, depending on their location in different areas. In the summer months, sheep rest in the pasture for 3-4 hours during the day. At this time they are also watered. At night, it is fully grazed and free-fed. Also, the fields where cotton, corn, wheat, barley, mung beans (mush), melons, and other types of crops are harvested for sheep feeding are also rented.

IN CASE OF SHEEP FARM. It was studied that large farmers reserve 150 kg of hay per sheep for the winter months (for 90 days) except for grazing. For example, buying dried Alhagi costs around 400.0 UZS per 1 kg. As an additional feed, 0.5 kg of barley per day is given to keep the sheep healthy from the winter (on average, one sheep consumes 150,000.0 UZS of barley during the whole winter). Mostly women are hired to harvest carrack in summer and Alhagi in autumn to stock up for winter. The number of women hired for these jobs can reach 40 and they work 60-90 days a year. They are paid 80,000.0 UZS per day for their work.

Sheep grazing varies depending on types of sheep herders, their economic condition and location, the number of sheep in the flock, the quality of the pastures, the supply of feed and fodder products, and other factors.

IN CASE OF THE SHEEP CLUSTER OPERATING IN SAMARKAND REGION

General info: The total land area owned is 44,000.0 hectares (25,000 hectares of leased land) and the total number of small ruminants is over 13,000 head. Number of goats in the flock is slightly more than 1,000 heads. The number of herds has decreased in the last 3 years due to lack of fodder and pasture, marketing issues of meat, leather and wool. Total number of workers is 62, of which six are women. The number of members of the cluster is 17 sheep farms.

Grazing distance: Although it has its own pasture, it sends sheep to other remote areas to graze due to low rainfall and low species of forage plants in the pastures. During the year, the cluster grazes sheep over a total distance of more than 1,200 km from its location - Navoi region (Uchkuduk, Tomdi, Nurota, Zarafshan districts) - Bukhara region (Karavulbazar) - Jizzakh region (Forish, Zomin districts).

Types of grazing areas and grazing fees: Small ruminants are grazed in the following areas in different regions: Kattakurgan district, Samarkand region (on harvested cotton fields), Jizzakh region (on mountain pastures and harvested grain fields), Navoi and Bukhara regions (on desert pastures).

Grazing in desert pastures - 25,000.0 UZS (USD 2.0)/per sheep;

Grazing in wheat harvested field - 50,000.0 UZS (USD 4.0)/per sheep;

Grazing in cotton harvested field - 30,000.0 UZS (USD 2.4)/per sheep;

Transportation of sheep to pastures: Sheep are transported to pastures in the regions in large trucks. 180-190 sheep are transported in one truck and the transportation cost for 300 km one way is UZS 3,500,000.0 (USD 280.0).

During the winter months, farms allow farmers and households to graze their sheep on their winter wheat fields. Sheep eat the sprouted parts of the wheat, the barley roots will grow stronger, and the strong winds and rains of the spring will not blow them to the ground.



Household small ruminants grazing in and around ditches in fields.



Sheep grazing in fields of winter barley.

Grazing of small ruminants on cultivated fields in winter months. (©Photo/ Sirojiddin Eshmatov)

This opportunity is mainly in January-February. With the onset of spring, grazing of livestock is not allowed on the fields planted with wheat.

Challenges related to feed and feeding

During the survey, 75% sheep breeders reported that the number of sheep they own decreased in the last 3 years, about 3% reported that the number did not change, and the remaining 22% reported that the number of sheep increased. The reasons why the number of sheep decreased or did not change were studied and it was found that various factors influence this.

Factors hindering the increase in the number of sheep

Factors	Decreased	Constant	Increase
	75%	3%	22%
Financial issues	A	A	C
Lack of feed and pasture	A	A	A
Lack of sheep housing in winter	C	B	D
Lack of time	D	D	D
Other	High cost, Low margin	Selling issues, Diseases	Diseases

Factors' effect level: A-strong, B-Moderate, C-Low, D-No effect
Source: Survey data

There are a number of fodder-related problems, such as poor pasture quality and fodder sources, interruptions in fodder supply, shortage of fodder products in different seasons, high cost of fodder products (especially in winter), and lack of quality nutritious crop planting practices across the country. The salinity level is increasing in the land areas where food and other main agricultural crops are grown. As a result, this is an obstacle to increasing the land area for planting nutritious crops for livestock. It is becoming difficult to feed small ruminants in the desert and sub-mountain regions with the decrease in the quality of the pastures.

Soil quality in sites

As a result of land salinization and degradation of pastures, it creates a big problem not only in the cultivation of agricultural and food products, but also has a negative impact on the development of the livestock sector.

Quality of agricultural land in the regions in 2022

Regions	Total irrigated area, mln ha	Non-saline area	Saline area				Share of saline area in irrigated area
			Total saline area	*including*			
				Low salinity	*Medium salinity*	*Strong salinity*	
Khorezm	265.4	0.0	265.4	152.2	81.3	31.9	100.0%
Syrdarya	287.8	7.1	280.7	230.2	45.9	4.6	97.5%
Bukhara	274.9	38.6	236.3	170.7	59.1	6.5	86.0%
Navoi	123.0	22.5	100.5	87.8	11.9	0.8	81.7%
Jizzakh	300.4	67.2	233.2	150.9	76.9	5.4	77.6%
Karakalpakstan R.	508.6	125.5	383.1	152.2	189.6	41.3	75.3%
Kashkadarya	514.9	284.4	230.5	175.6	43.6	11.4	44.8%
Fergana	362.7	237.5	125.2	102.5	20.8	1.9	34.5%
Surkhandarya	325.7	227.0	98.7	69.6	28.1	1.0	30.3%
Namangan	282.3	258.9	23.4	16.5	6.2	0.7	8.3%
Andijan	265.9	258.3	7.6	3.2	4.4	0.0	2.9%
Tashkent	398.4	387.7	10.7	8.9	1.7	0.0	2.7%
Samarkand	379.5	374.9	4.6	4.3	0.3	0.0	1.2%
Total	**4,289.6**	**2,289.6**	**2,000.0**	**1,324.6**	**569.9**	**105.5**	**46.6%**

Source: https://data.egov.uz

As we see from above table that land salinization is 46.6% in Uzbekistan which is 2.0 mln ha out of total 4.28 mln ha irrigated area. Of the total salinity land, 66.2% is low salinity, 25.5% is medium salinity and 5.3% is high salinity.

Another problem related to fodder is that more than 50 percent of pastures in Uzbekistan are in crisis to varying degrees. The negative impact of pasture degradation on food security, agricultural production, and the environment is increasing. 11 million hectares of pastures in the republic have decreased in natural fodder production potential and have become unusable . Some outstanding issues regarding the efficient use of rangelands, their control and the fight against degradation remain relevant. Due to the insufficient introduction of the livestock rotation system in the pastures and the sharp increase in the number of livestock, the pasture lands are under high pressure. As a result, nutritious fodder plant species have become scarce and have reached the point of extinction.

The following negative trends in desert pastures are occurring in the surveyed areas:

- pastures are decreasing due to strong degradation;
- plant species are disappearing due to low rainfall and lack of irrigation;
- financial problems of farms in plowing pastures, irrigation and organizing other types of infrastructures are increasing;
- long-term grazing of more than normal number of sheep in wet pastures makes the soil denser;
- precipitation does not soak into the soil, and as a result, the growth of plants with deep roots and long vegetation slows down;
- water erosion occurs, ravines appear;
- pastures can be used only in spring, and in summer, plants do not grow;
- these result in the growth of grass-forming plants and this is a sign of degradation. Soil erosion can lead to the loss of valuable topsoil, which is essential for plant growth;
- only root-propagating plants will grow and seed-propagating plants will decrease. This is considered a negative indicator.

Potential interventions to address the challenges

It is necessary to strengthen the effective use of pastures, their control and measures to combat degradation. It is very important to systematically carry out scientific research on the state of vegetation cover in pastures, the trend of degradation processes, the study of the economic potential of pastures and the development of a system of rational use of pastures on this basis. It is necessary to review the system of training specialists in the field, develop education and training programs based on foreign experiences, and solve the problem of staff shortage on this basis. Establishment of forest plantations in desert and semi-desert areas, strengthening of rehabilitation of pastures in crisis, and expansion of special programs aimed at preventing the increase of soil erosion and dust formation under the influence of wind are considered important directions. Excavation of shaft and vertical wells, construction and reconstruction of pumping stations in the areas of high water shortage pastures on the principle of public and private partnership will also bring long-term positive results.

5. CONCLUSIONS AND RECOMMENDATIONS

- creation of scientific and practical bases for intensification of feed production in desert areas, organization of seeds of desert nutritious plants;
- introduction of advanced agrotechnical measures in areas where seeds of desert nutritious crops are grown, providing these areas with quality seeds and increasing the volume of seed cultivation;
- selection of suitable varieties and rapid reproduction of their seeds, taking into account the climatic conditions of pastures;
- identifying and restoring pastures in crisis and planting desert nutritious crops to increase their productivity;
- supply of seeds of nutritious crops based on the demand of farms specializing in sheep breeding.
- to further reduce GHG emissions
- considering options for rotations or intercropping of food and cash crops with forages, and more adequate and strategic use of higher-cost agroindustrial by-products.
- ensure the production and availability of seedlings of (leguminous) forage trees for silvopastoral systems by establishing regional and local nurseries.
- introduction of non-traditional annual forage crops such as sorghum, triticale, barley and oats, and perennial legume forage crops such as alfalfa and aspartame (supplemented with corn as feed);
- introduction of the concept of determining the types of fodder in summer and winter pastures, as well as their productivity, alternating grazing, planting and restoration of pastures;
- training of farmers and representatives of local non-governmental nongovernmental organizations on sheep and goat keeping, feeding, medical services, fodder cultivation and storage methods;
- introduction of new methods (for food production) such as aquaponics and hydroponics, which should be developed and promoted throughout the country.

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