



InsuResilience
Solutions Fund



Feasibility study

Insurance of fruits and vegetables in Uzbekistan

Prepared by Dr. Olena Sosenko
with assistance and on behalf of IDF and UNDP
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Table of Contents

Executive Summary	1
CHAPTER 1 – CROP PRODUCTION	4
1.1 Statistical overview and maps of crop production and values in Uzbekistan	4
1.2 Horticultural subsector	6
1.2.1 Overview of the horticulture subsector	6
1.2.2 Structure of the horticulture subsector.....	7
1.2.3 Key types of fruit and vegetable, their productivity and export value	8
1.2.4 Horticulture development trend	9
1.3 Export values and investment projects	10
1.4 Major donor/development institution initiatives in the Uzbek agricultural sector	11
CHAPTER 2 – FARMERS	14
2.1 Statistical overview of farmer’s income by farm size	14
2.2 Farmers’ interest to agricultural insurance	18
CHAPTER 3 – IRRIGATION SYSTEM IN UZBEKISTAN	19
CHAPTER 4 – CHALLENGES OF THE AGRICULTURAL SECTOR	21
4.1 Current challenges	21
4.2 Climate change	23
4.3 Agricultural risks	25
CHAPTER 5 – INSURANCE	27
5.1 Legislation status quo and improvements	27
5.2 Insurance industry in Uzbekistan	30
5.3 Status quo of agricultural insurance	31
5.4 Description of Uzagrosugurta	32
CHAPTER 6 – FUTURE AGRICULTURE INSURANCE PROGRAM	35
6.1 Description of how aggregators and clusters could support insurance scale up	35
6.2 Overview of Ministry of Agriculture main strategy, interest in extended crop insurance, possibilities for premium subsidy support	36
6.3 International experience and reinsurance	36
CHAPTER 7 - CONCLUSIONS	37
7.1 Conclusion if Uzbek farmers target group meet the farmer income requirements of the ISF project funding guidelines	37
7.2 Estimation of crop insurance market size	39

7.3 Assessment of the long-term viability of an extended crop insurance scheme. Indemnity based vs index insurance.39

7.4 Recommendations for pilot crops and regions42

List of stakeholders for agricultural insurance implementation..... 43

Attachments 44

 a) Climate of Uzbekistan and weather observations44

 b) Some technical aspects of spring frost and frost protection45

Maps and figures 47

References..... 48

Executive Summary

Since 2021 a working group, comprising of Swiss Re, Axis Capital and UNDP Uzbekistan, and supported by the Ministry of Agriculture of the Republic of Uzbekistan, is elaborating a Concept Note for a National Agricultural Insurance Scheme in Uzbekistan. The Concept Note initially submitted to InsuResilience Solutions Fund (ISF) proposed the development of index insurance for cotton and wheat and traditional indemnity insurance for horticulture. Based on feedback from ISF regarding the eligible target sector, the working group suggested to redirect the project to horticulture where the insurance benefits could be focused on smallholder and thus the low-income farmers in Uzbekistan. To better assess this sub-sector a feasibility study was initiated to address the data and information gaps for horticulture industry, risk profile and income coming from the farming activity as well as to analyse the agriculture insurance market and regulation. Therefore, as it was decided by the working group, the feasibility study focused on the potential multi-peril indemnity insurance product as a coverage for the most vulnerable farmers of the fruit and vegetable sector.

The study focusses on such aspects as horticultural production and export volume, categories of farmers, farm risks, status quo, capacity and prospective of Uzbek insurance market. Major objective of the feasibility study was to evaluate the viability and scope of horticultural insurance in Uzbekistan with the service focusing on low-income farmers. This report summarises all findings of the undertaken feasibility study.

The feasibility study included the following stages and activities:

- Literature and documents analysis;
- General data collection;
- Visit of the country stakeholders in Tashkent;
- Farmer's survey/questioning;
- Analysis of all collected material and discussions with the working group.

The statistical data that is provided in the current report was derived from various sources, such as: existing reports and documents, evidence of the farmers from the survey, interviews with different stakeholders in Tashkent, data specifically requested from the Statistical office of Uzbekistan and expert assumptions (agronomical and insurance). During the farm survey 29 representatives of commercial farms and 43 representatives of dehqan farms from 6 administrative regions (oblasts) were interviewed. The survey result was summarised in the number and descriptive forms.

The feasibility study assured that agricultural industry is one of Uzbekistan's dominant economy sectors that ensures the country food security but also provides a substantial export income for the country. Uzbekistan is not only internationally known as a large cotton producer, but also for its fruit and vegetable products due to the very favourable climate and soil conditions. While cotton and grains (mostly wheat) are grown by big agricultural

producers – corporates, clusters and commercial farmers, the fruits and vegetables are widely produced by smaller farmers including dehqans¹ and private households. Fruits and vegetables are the major income source for smaller farmers. The horticulture production is evenly spread around the country and is mostly fully irrigated. By the national statistical standards, the Uzbek horticulture sector is grouped in such categories as potatoes, vegetables, fruits and berries, melons and grapes. The regions especially known for horticulture production are the Fergana Valley and Samarkand.

The climate in Uzbekistan is dry with high temperature fluctuation. The biggest advantage of the climate in Uzbekistan is a generous solar energy, but its biggest disadvantage is a moisture deficit and dependency on irrigation with the major water source laying outside of the country. The country has 4 climate zones, of which Mediterranean and continental are most suitable for agricultural production.

Furthermore, climate change is clearly evident in the form of temperature fluctuation, winter shortening, highly damaging spring frosts and unfavourable precipitation redistribution. Due to climate change the water deficiency will be even deepening in the future, which requires an implementation of water saving technologies, for example, drip irrigation^{v, ix, xix}.

The agricultural industry in Uzbekistan is going through intensive process of transformation and modernisation. Both the national government and multiple international organisations are dedicating substantial investments to the agriculture enhancement strategy. This strategy involves the land transfer from cotton to horticulture production, implementation of intensive agricultural technologies, optimisation of irrigation, farmers education and expansion of their financing. World Bank, Asian Development Bank, Food and Agriculture Organisation, European Union as well other donors are substantially contributing into the construction of agriculture-food industry infrastructure and value chain.

The agricultural producers in Uzbekistan are divided into clusters, commercial farmers, dehqan farmers and private households. The concept of clusters has been introduced in the country recently, in order that big holdings could uplift the operation of smaller farmers. Commercial farms are the major producers of fruits and vegetables in the country; however, they cannot be categorised as small-income entities. Dehqan farmers is the most common form of non-commercial farming actively producing fruits and vegetables partly for market sales and partly for own consumption. Due to land size limitations, dehqan farms generate a revenue that falls below the ISF recommended threshold of the low-income category. According to the current project farm survey dehqan households have 0.77 hectares of land and earn USD 12.87 PPP of income per capita in average, while commercial farmers respectively - 12.11 hectares of land and USD 153,00 PPP of income. Private households are also producing fruits and vegetables but mostly for own consumption.

¹ In [Uzbekistan, household plots](#) were reclassified as "dehqan farms" in 1998, at which time the Law of Dehqan Farms was passed.^[1] Around 60% of all agricultural production in the country comes from dehqan farms. Source: [Dehqan farm - Wikipedia](#)

All stakeholders interviewed during the study, including agricultural producers, admit high level of risk for fruits and vegetables production. Spring frost, irrigation deficiency and pest/diseases are indicated as biggest risks. As witnessed by farmers, spring frost was especially devastating for orchards and vineyards during the last 2-3 years. It caused the biggest losses of fruit yield and trees in the recent decade. Considering this risk, the interviewed farmers have shown interest to have such risk mitigation tool as insurance and would be even willing to pay for it around or below 5% of the insured value. Normally – based on international experience - the comprehensive insurance for fruits and vegetables costs higher than 5%, thus, the state subsidy should cover the insurance premium above this threshold. Currently the government is providing a 50% insurance premium subsidy to horticulture farmers with export contracts. The government has also committed to diversified support of the future fruits and vegetables insurance program for all types of farmers.

At the current stage commercial farmers and especially dehqan farmers have limited access to credits and less even to insurance (currently subsidized by the government, when linked to credit). Generally, the agricultural insurance product promotion might be more successful, if insurance is bundled to credits. Lending and insurance need to have a cross influence and a mutual development trend towards a higher financial literacy and more intensive use of financial tools by farmers. Alongside credit institutions, other farm aggregators, such as cooperatives and the Council of Farmers, could be considered as a channel for agricultural insurance distribution. Such organisations will need to be rewarded through an insurance agent commission; their staff should be respectively trained on agricultural insurance products.

Consultations with the country stakeholders and experts during the feasibility study lead to the conclusions about the first horticulture insurance pilot in Uzbekistan. Such crops as apricots, cherries and grapes are recommended as first priority for insurance product development. The insurance coverage should be built as an indemnity insurance. Fergana valley with its 3 oblasts – Fergana, Namangan, Andijan - are recommended as pilot regions.

The Ministry of Agriculture (MoA), the Insurance Market Development Agency, the Council of Farmers and the local UNDP office are the key project stakeholders during the insurance product development and first piloting.

CHAPTER 1 – CROP PRODUCTION

1.1 Statistical overview and maps of crop production and values in Uzbekistan

Agriculture plays an important role in Uzbekistan’s economy. Around 17,35 mln people – 49% of the population - reside in rural areas and most are employed in agriculture. Agricultural development is therefore crucial for ensuring rural livelihoods, jobs, and food security ⁱ. The country’s agriculture food sector includes crop production, livestock, fishery, forestry and a food processing sector. Agriculture, forestry and fisheries produces about a third of the GDP (28.1% in 2019). The overall agriculture and food sector contributes more than 40% to the national GDP (40.9% in 2019) ⁱⁱ.

Table 1. Share of agricultural industry in Uzbekistan national economy, 2019 ⁱⁱ

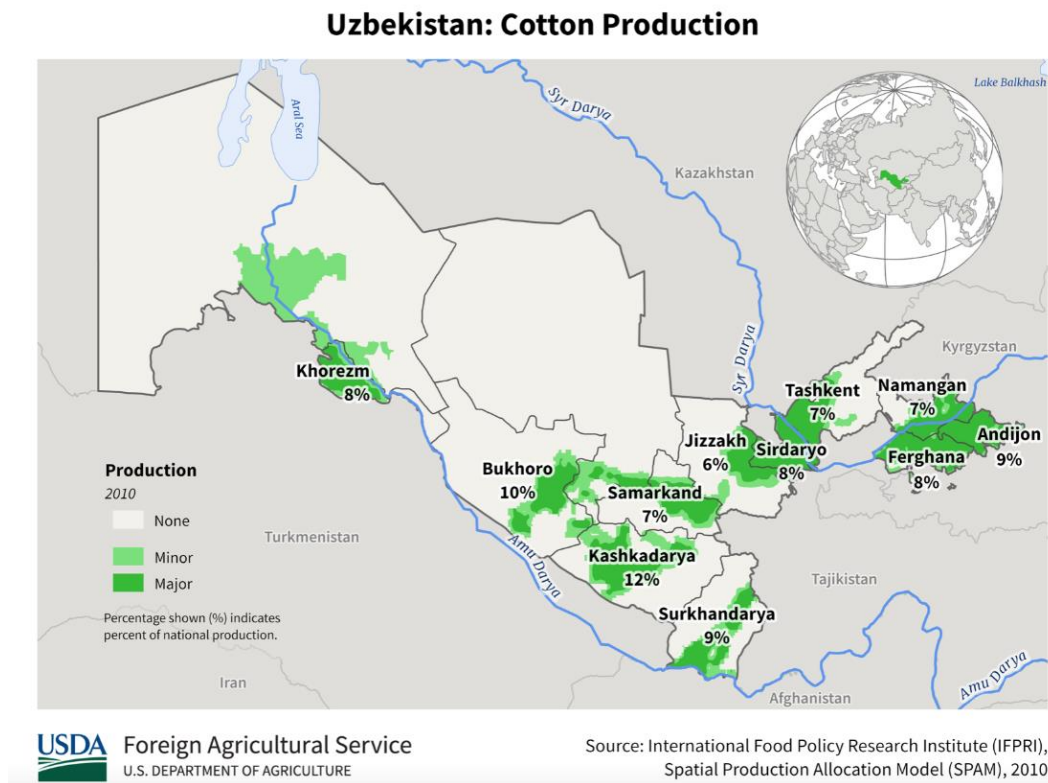
Sector	Agriculture share, %
Employment	30.4
GDP	28.1
Fixed capital investment	15.7
Export trade	17.2

Agricultural production is concentrated on a land area of 20,469 thousand ha (or 54.4% from total land of the country). Agricultural land includes 11,143.8 thousand hectares of pastures and hayfields, 4,035.5 thousand hectares of arable land, 354 thousand hectares of tree plantations and 4,935 thousand hectares of the other plantationsⁱⁱⁱ. Rainfed agriculture is concentrated in piedmont plains, foothill belts and in the mountains of Tien Shan and Pamir-Alay on the area of 753.6 thousand hectares (or 18.6% from the total area of arable lands). Insufficient natural moisture supply on non-irrigated land leads to low productivity and unstable yields.

The total irrigated land is more than 4.3 million hectares, which is the main asset of agricultural production. Irrigated arable land occupies 81.4% from the total irrigated land. The main irrigated crops are winter wheat and cotton, covering around 68% from the total irrigated land area. Potato, forage crops, vegetables, melons and other crops are grown on the rest of irrigated land area. Perennial plantations include various fruit trees: apples, pears, cherries, plums, peaches, apricots, grapes, pomegranates, persimmon ⁱⁱⁱ.

Uzbekistan is the second largest cotton exporter worldwide, where cotton has traditionally dominated the agricultural sector, occupying (together with wheat) more than 65% of cultivated land in the country.

Map 1. Cotton production areas in Uzbekistan ^{iv}



Due to very favorable climate and soil conditions Uzbekistan is one of the largest producers of fresh fruits and vegetables in the world ^{iv}. Agriculture production has been steadily increasing in the absolute terms and has doubled in real terms in the last 20 years.

Figure 1. Planted agricultural land by crops, hectares (2015-2019) ^{iv}

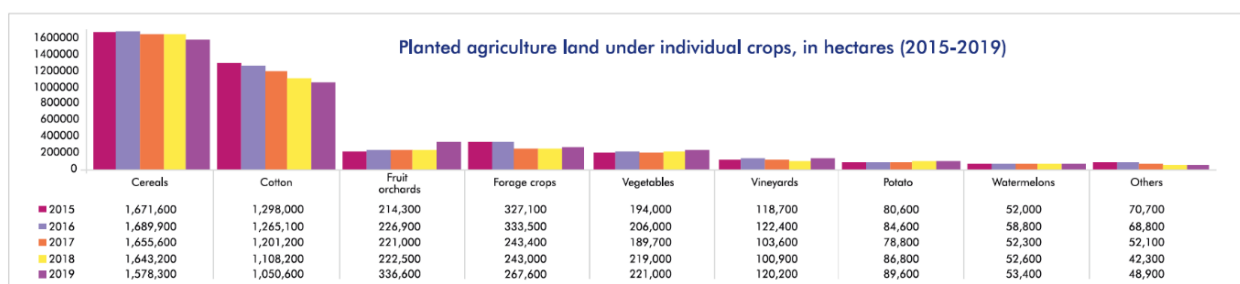
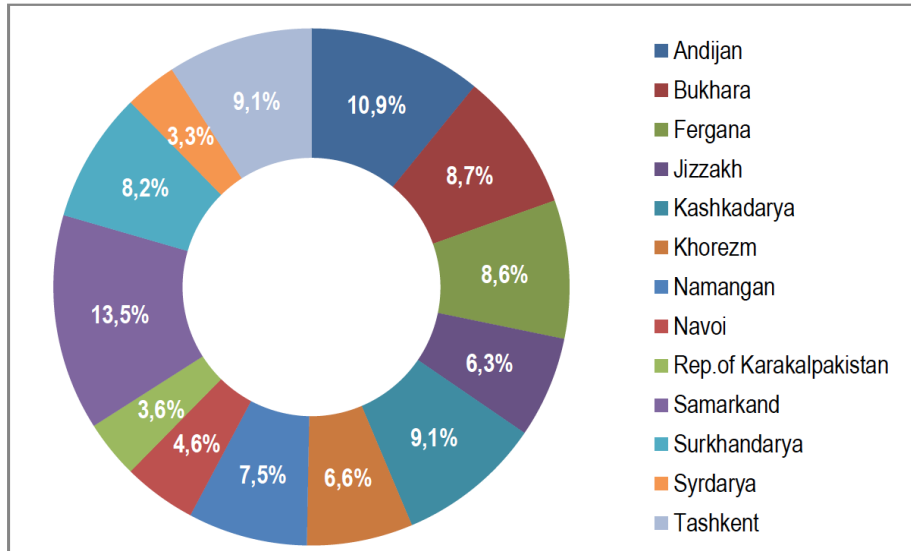


Table 2. Production area of different crops, hectares, 2019 ^{iv}

Crop	Area (in ha)
Cereals	1,578,300
Cotton	1,050,600
Fruit orchards	336,600
Forage crops	267,600
Vegetables	221,000
Potato	89,600
Watermelon	53,400
Other	48,900

The distribution of the total volume of agricultural production is relatively equal across the regions. Samarkand region has the highest share of production with 13.5%, followed by Andijan and Tashkent regions with indicators of 10.9% and 9.1%, respectively ^v.

Figure 2. Agricultural production distribution by regions (Uzstat, 2019)



Large-scale reforms are taking place in the agriculture-food sector. An ambitious program of liberalization, institutional and structural changes was launched in 2017. The government is seeking new investment partners that can bring access to new expertise, experience and innovation. This provides significant new opportunities for further expansion and diversification of the agri-food sector.

1.2 Horticultural subsector

1.2.1 Overview of the horticulture subsector

Horticulture is an important part of agricultural production in Uzbekistan, although the subsector accounts for only about 16% of aggregate arable lands, in contrast to grains (47%) and cotton (37%). In 2018, horticulture generated 53% of gross agricultural output. According to the state statistical reports horticulture products are grouped into the categories of potatoes, vegetables, fruits and berries, melons, and grapes.

Uzbekistan has become a major producer of horticultural products in the Central Asian region, with the potential to expand exports. Production of fresh fruit and vegetables has continually increased since the 1990s and particularly in recent years, making currently up 40% of the national agricultural exports, with half of this value falling on small and medium-size enterprises. At the same time most of the horticultural goods are destined for domestic markets.

Production of fruits and vegetables is among the most profitable activities for both dehqan (smallholder farms) and more commercial farms. The majority of dehqan farmers are still predominantly consuming large proportions of their own production and bartering or selling any small surplus on nearby retail markets —products are sold in small lots in the administrative district centers nearest to the farm. Horticulture also has a greater than

average positive impact on employment amongst other agricultural sectors and in food processing industry ^{vi}.

The horticulture sector also provides an important year-round source of income in rural areas for women and creates opportunities for them to generate income and improve their standard of living. Within horticulture activities women can earn through processing, seed production and nursery preparation. The World Bank investments in horticulture sector led to greater female labor force participation. Enterprises participating in the program showed a 67% increase in the number of female employees.

1.2.2 Structure of the horticulture subsector

According to the Horticultural and Greenhouse Development and Agency, Uzbekistan has 25,000 orchards with 160,000 hectares of net planted surface (gross area of 190,000 ha). The average farm size, considering the gross area, is 7,6 hectares with apples occupying 43% of the area. Important to remark is that more than 80% of the orchards are over 50 years old and should be replanted by younger seedlings.

Some of the regions of Uzbekistan are specialized in the production of a particular type of fruit, others host many fruit/vegetable types. The Fergana valley is one of the main fruit producers in Uzbekistan where wide variety of grapes, apricots and peaches are produced. Syrdarya, Kashkadarya (Varganza) and Surkhandarya are the main producers of pomegranates. Namangan is well known for its apricot, cherry, prune and persimmons. Walnut orchards and forests in Kashkadarya produce almost 60% of walnut production of Uzbekistan. In recent years, new walnut orchards were planted in Jizzakh and Samarkand. The climate of Surhandarya is very suitable for most fruit types. Furthermore, Surkhadarya and Kashkadarya’s harvests are a month earlier compared to other regions. In general, Andijan, Samarkand and Fergana are the most important fruit-growing regions according to the official statistics from 2018.

Table 3. Fruits, berries and vegetables production per region per type in 1,000 tons, 2018, (Source: stat.uz ^{iv})

Region	Fruits and berries	Vegetables	Melons, pumpkin	Potatoes
Andijan	569	1,540	135	295
Samarkand	338	1,415	100	570
Fergana	295	837	63	250
Bukhara	280	700	150	150
Namangan	250	750	72	171
Kashkadarya	172	480	157	146
Surkhadarya	150	900	242	280
Khorezm	146	560	132	123
Tashkent	123	1,257	149	338
Navoi	100	275	88	100
Jizzakh	80	390	230	50
Rep.Karakalpakstan	50	274	140	80
Syrdarya	28	290	265	28

The horticultural produce is processed, in the form of pulps, pastes, purees, dried products and juices, etc. Between 2004 and 2015, the overall volume of processed horticultural products increased from 550,000 tons to over 2,500,000 tons. Most processing firms have several intermediaries for primary product supply but quite often experience lack of steady and reliable supply of quality produce.

1.2.3 Key types of fruit and vegetable, their productivity and export value

Cherry. Uzbekistan ranks fifth in the world in terms of total cherry production volume with 95,000 tons and had 4.1% shares of world imports in 2019. Cherries are one of the most promising export-oriented fruit crops for Uzbekistan. The harvest season for the fruits start the end of April and continues till the end of July. The most important producers of cherries are situated in Tashkent and Namangan region.

Apricot. In 2019, Uzbekistan ranked second after Turkey with 662,000 tons of apricot production and had a 17.1% share of world imports. Apricot harvest in Uzbekistan is between April and September, and local varieties and cultivars of apricot are Galta Roja Apricot, Moniqui Apricot, Dina Apricot, Spring Gold Apricot and Brittany Gold Apricot.

Potato is the third most produced crop after vegetables and cereals. According to the official statistics, the annual consumption of fresh potatoes is around 54 kilograms per capita. Both potato production and consumption have shown an upward trend driven by population growth and changing consumption patterns. Most potatoes were planted in the Samarkand area on almost 17,000 hectares of land in 2017, followed by the Tashkent region on almost 15,000 hectares in 2017. Two crops per year are planted in Uzbekistan, first the spring crop from February till June and the shorter autumn crop from the end of July to the end of October. According to the official statistics, the total harvest was around 2.7 mln tons in 2018. This means a statistical average yield of 30 tons per hectare, which is well above the world average. In July 2021, the Ministry of Agriculture of Uzbekistan and the International Potato Center (CIP) launched a five-year program “Improving food security and climate resilience in Uzbekistan through breeding and seed production of potatoes and sweet potatoes”. The expected result of the program is an increase in the yield of potatoes produced in the republic by at least 30% due to higher biological productivity of new varieties and their better resistance to risks. In accordance with the government decision on planting various crops on agricultural land, 86.5 thousand hectares were allocated for planting potatoes in 2021 ^{vii}. The projected potato planting area in 2022 could amount to 122,000 hectares.

Tomatoes, watermelons, carrots and onions. These are the most popular vegetable crops in Uzbekistan, accounting for 75% of the total area for vegetables. The main vegetable cropping season in Uzbekistan is from March till the end of October. Tomatoes are cultivated in open fields—during the long hot summer—and in plastic greenhouses and tunnels to prolong the season ^{iv}. Uzbekistan produced 11.5 mln tons of vegetables and melons in 2018. Dehqan farmers account for 75% of vegetable production and 60% of melon production. Andijan, Samarkand and Tashkent are major vegetable-producing districts. Although all districts of the country produce melons, Syrdarya, Surkhandarya and Jizzakh are the major regions.

Apples. For the understanding of the apples yield potential in Uzbekistan the following expert quotation could be representative: *“The average annual extensive production of Class 1 apples is from 2 up to 5 kg and the average annual intensive production of Class 1 fruit is from 10kg up to 15 kg. However, if better managed, the marketable yield should be over 30–50 tons/ha”*^{iv}.

The production of vegetables and fruits however still falls short of their maximum potential and of the national food security targets. Currently, the horticultural output per hectare is low, post-harvest losses due to insufficient storage and transportation infrastructure are considerable and there is a knowledge gap deterring progress in the ambitious speed expected by the government^{iv}.

1.2.4 Horticulture development trend

The Uzbek government has developed a new agricultural strategy 2020–2030 that is aimed at reforming the horticultural subsector (i.e. potato, vegetable and fruit) into a modern, export-oriented sector^{iv}. In the decree “On Measures to improve the Efficiency of the use of Land plots of Farms in the Area of Vegetable Growing, Melon Crops, Horticulture and Viticulture” issued by the government in April 2018, it was indicated that almost 100,000 hectares were to be transferred from cotton and grain to horticultural land use. The candidate regions for the modernization are Syrdarya (20,143 ha), Surkhandarya (16,222 ha), Namangan (11,294 ha) Kashkadarya (10,000 ha) and Jizzakh (10,000 ha)^{iv}.

In 2019 the **Horticulture and Greenhouse Development Agency** was created under the management of the Ministry of Agriculture. The Agency’s main tasks are to increase the area of greenhouses, use modern resource-saving technologies, such as drip irrigation, develop a cooperative system and organize the value chain from harvesting to selling. It plans to establish cooperatives in 55 areas. The Agency reports that there are 1,800 different farms with greenhouses, covering a total area of 4,100 hectares^{iv}.

President Shavkat Mirziyoev signed the decree about the efficient use of the irrigated land and agricultural production in Tashkent. This decree advises^{viii}.

- the crop is cultivated by a plantation method on the holistic area;
- the land with the size below 20 hectares is given into leasing to reduce unemployment. The MoA will plant the orchards and vineyards on those plots and then allow unemployed people to harvest the products within 7 years;
- on all plots that are given to Tashkent the crop production will be organized according to standards of processors and exporters;
- the processing and storing factories will be established starting from the year 2022.

The president also signed a decree for development of a family business in agricultural sector. According to this decree in the nearest 4 years 200,000 hectares will be freed from cotton and grain and will be given to farmers and clusters. From this land fund people could rent plots from 0.1 to 1 hectare for production of vegetables, potato, melon, legumes and oil crops. 80 hectares of such land will be transferred already in 2022. Starting from 1st of December the

vegetables producers will be able to get credits from the **State Agricultural support Fund** through an accredited bank. For this purpose, 3-sided agreement will be signed between a cluster, a farmer and a bank. The credits duration is 1-year, maximum amount USD 100 mln sum with the interest rate of 14%. The credits could be used also for planting of orchards and vineyards. For such credits the government will redirect USD 100 mln that were received from international financial institutions ^{viii}.

1.3 Export values and investment projects

Uzbekistan is the second largest **cotton** exporter worldwide, where cotton has traditionally dominated the agricultural sector, occupying (together with wheat) more than 65% of cultivated land in the country. Due to very favorable climate and soil conditions Uzbekistan is one of the largest producers of fresh **fruits** and **vegetables** in the world ^{iv}. Agricultural production has been steadily increasing in the absolute terms and has doubled in real terms in the last 20 years. Uzbekistan is moving from an inward-oriented economic model towards a more open, integrated and export-driven economy aiming to become one of the leading producers and exporters of high-value agriculture-food products in Central Asia ^{iv}. The government has been promoting an active state agriculture policy, aimed at efficiency and sustainability as well as food security ^{iv}.

Uzbekistan aspires to become a global horticulture powerhouse, which would help to create many well-paid jobs along the export-oriented value chain and generate other economic and social benefits. Being 'export oriented' is crucial to realize the sector's full potential as domestic market has been already saturated. In 2019 the leading agriculture export product was cotton (43% of total/USD 1,293 mln), while the second most significant agriculture export category was fruits and nuts (21% of total/USD 644 mln) and the third most significant agriculture export product was vegetables (15.8% of total/USD 473 mln) ^{iv}. Uzbekistan exports more than 180 kinds of fresh and processed horticulture products. The export geography has expanded over the last 5 years to trade with more than 80 countries.

The top fruit category exports include grapes, apricots, cherries, peaches, nectarines, plums, sloes, strawberries, raspberries, blackberries, currants and gooseberries. In 2019, Uzbekistan was one of the leading countries on exporting fresh apricots with 2nd place, 4th place for persimmons, 7th place with fresh cherries and 10th place for fresh peaches.

The major trade partners for Uzbek agriculture products are China, Russia, Kazakhstan, Turkey and South Korea. The most important destination for horticultural products (for example, apricots and melons) is Russia, while for vegetables 50% are destined for Kazakhstan. The value of Uzbek Agriculture-food exports has become much more diverse over time ^{iv}. The horticulture export grew from USD 570 mln in 2017 to USD 1,200 mln in 2019 ^{iv}. Yet, horticulture exports are still concentrated in countries and in markets, which have lower market price for Uzbek products compared to other markets due to insufficient quality standards.

Success in exporting the horticulture products requires paying attention to quality, reliability, safety, and logistics. Making improvements in these areas in Uzbekistan would require addressing constraints related to: (i) quality and availability of services for raising on-farm

productivity and output quality; (ii) value chain organization and inclusion of smallholders; (iii) land availability and land tenure security; and (iv) facilitation of trade through better agriculture-logistics, Sanitary and Phytosanitary Measures (SPS) and food safety systems, and quality assurance. Currently very little of the agricultural public expenditures in Uzbekistan are spent on these programs, implying that the existing capacity in most public institutions for delivering agricultural services is weak.

The Government is actively supporting export expansion, seeking to transition farmers from traditional cotton and wheat production to higher-value and less-water intensive horticultural crops and encouraging almost 5 million households to use their plots to grow vegetables and fruits too. A series of strategic, legislative and regulatory documents were recently adopted promoting support to the sector and establishing new institutions and responsibilities. These include for example:

- the Action Strategy in Five Priority Development Areas of the Republic of Uzbekistan for 2017 – 2021 which was adopted by Decree № 4947 of 7 February 2017 by the President of the Republic of Uzbekistan, defining the modernization and intensive development of agriculture as an important element of economic development, and calling for optimized land-use by gradually replacing water-intensive cotton and cereals with, i.a., potatoes, vegetables, intensive gardens, vineyards and other higher-value crops – as well as for the overall adaptation of agriculture to global climate change. Under the new Action Strategy, new intensive orchards and vegetable plantations are to be created in particular on 445,000 hectares of arable land in 66 districts and 215,000 hectares of land released from cotton and grain cultivation in 2017 – 2020.
- the Decree № 3893 of 1 August 2018 by the President of the Republic of Uzbekistan “On supplementary measures to optimize the structure of cultivated land, increase the production of fruit, vegetables and other agricultural crops and their export in 2018” introduced 2018 area and outputs targets envisaging 817,000 tons of extra output to be produced in areas converted from cotton and wheat, and 266,000 tons of fruit, vegetables and other agricultural produces additionally available for export.

The mentioned strategy is, perhaps, not fully finalized up to the current moment; the respective action continues.

1.4 Major donor/development institution initiatives in the Uzbek agricultural sector

Acknowledging the high importance of agricultural industry in Uzbekistan many international organisations are financing and implementing projects in this sector. The activity of such organisations increased after Uzbek economy liberalisation in 2017.



Table 1. Short description of international projects in agricultural sector ^{ix x xi xii}

N	Donor/ Organisation	Projects and major objectives
1	World Bank (WB)	<ul style="list-style-type: none"> - 23 projects with net commitments USD 4.0 billion in water, agriculture, transport, energy, education, health, and urban development. <p>The WB focus areas for Uzbekistan are based on three pillars:</p> <ul style="list-style-type: none"> a) a sustainable transformation to a market economy b) reformation of state institutions and citizen engagement c) investments in human capital, including the development of the health and education sectors. <ul style="list-style-type: none"> - Disaster risk financing country note. Loans on disaster risk insurance (not directly agriculture) - Horticultural Development Project (USD 650 mln) - Agricultural Modernization Project (USD 500 mln)
2	Asian Development Bank (ADB)	<p>With its loan programmes, the ADB supports horticulture infrastructure, production, export, and efficient irrigation systems.</p> <ul style="list-style-type: none"> - Supporting ESG investors, clusters (e.g. Indorama), climate finance - Horticulture Value Chain Infrastructure Project <p>In total, 167 ha of greenhouses and 3,700 ha of orchards and cold storage facilities were constructed with the support of the credit lines provided by the ADB.</p> <p>A credit line of USD 198 million supports the establishment of horticulture clusters where production and post-harvest services can be consolidated to improve efficiency and economies of scale. It finances the establishment of Agro-Logistic Centres (ALCs)</p>
3	Food and Agriculture Organisation (FAO)	<p>Provides in depth knowledge through his consultancy networks and support to the Uzbek Government in three priority areas:</p> <ul style="list-style-type: none"> i institutional and policy assistance for the Ministry of Agriculture and other government institutions; ii agricultural and food value chain development and market access; iii sustainable management of natural resources, climate change and biodiversity. <ul style="list-style-type: none"> - Contributor to the 2020-2030 agricultural strategy process and conducted studies on organic agriculture, good agricultural practices and seed legislation
4	European Union (EU)	<p>Euro 168 mln had been allocated to the country cooperation, which focus on rural development. The EU provides support to the agricultural sector with the specific objective of strengthening local agri-food public services, increasing farm income and rural employment, enhancing food security, and ensuring the sustainable use of national resources.</p>



		The EU supports the WB and ADB horticultural projects with grants varying from Euro 5 mln to Euro 21 mln. The agricultural sector budget support for 2020-22 is Euro 40 mln. Knowledge transfer is one of the key areas.
5	International Finance Corporation (IFC)	<ul style="list-style-type: none"> - Extension services project - USD 61 mln investment portfolio, which mainly includes projects in the financial and textile sectors (co-investor of Indorama)
6	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	<p>There are 57 active projects with the portfolio size of Euro 57 mln. Sustainable Rural Development Project in 3 selected regions in Uzbekistan, which entails the following aims:</p> <ul style="list-style-type: none"> i promoting selected value chains ii green economy - Established 5 ha demo orchards to test commercial varieties in several regions.
7	Development Alternatives Incorporated (DAI) / U.S. Agency for International Development (USAID)	<p>Agricultural Value Chain Activity (AVC) that organised into four components:</p> <ul style="list-style-type: none"> i Improve the quality and volume of agricultural production; ii Improve post-harvest handling and production; iii Facilitate market linkages; iv Link educational institutions with private sector demand.
8	International Fund for Agricultural Development (IFAD)	<p>The Horticultural Support Project specifically focuses on the following:</p> <ul style="list-style-type: none"> i upgrading nurseries through the mechanism of a central nursery to import, test, and propagate modern varieties and root stock for sale in the horticultural value chain; ii modernising 10 to 15 private agro-firms in the horticultural production and processing sector; iii providing small-scale farmers with affordable investment finance, technical assistance, and training. <p>Agriculture Diversification and Modernisation Project (ADM), with a budget of USD 365 mln and following components:</p> <ul style="list-style-type: none"> i inclusive value chain development to enhance capacity and sustainable and efficient performance of stakeholders and enable a business environment for agriculture businesses; ii inclusive rural finance to increase productivity and efficiency among targeted smallholders and enable value chain actors to increase their investments in profitable value chains; iii climate-resilient rural infrastructure through modernisation of the inter-farm irrigation network operated by water consumer associations (WCAs) with the aim of diversifying agricultural production, increasing land productivity, and improving WCA's capacity for water.



		<ul style="list-style-type: none"> - Participation in Country Strategic Opportunities Programme (COSOP) preparation - Dairy Value Chains Development Program (DVCDP) - Provides credit lines for horticulture farmers including dehqan households - Written report on farmers
10	Central Asia projects	Various recommendations for farmers on crop producing technology
11	Japan International Cooperation Agency (JICA)	Value chain development in horticulture (USD 337,68 mln out of it USD 213.17 mln loan of JICA)
12	Korean international cooperation agency (KOICA)	Green rehabilitation investment project for Karakalpakstan Republic to address impacts of the Aral Sea Crisis (funded by KOICA)
13	Turkish Prime Ministry (TIKA)	Development of new fruits varieties, supplying seedlings
14	Agriculture and Rural Development (AFD)	Development of livestock production in Uzbekistan (EUR 7.6 mln)
15	German Development Bank (KFW)	Credit lines for financing MSME including farmers
16	Netherlands Enterprise Agency (RVO)	Plant propagation, horticulture technology

CHAPTER 2 – FARMERS

2.1 Statistical overview of farmer’s income by farm size

The Republic of Uzbekistan consists of 12 provinces, 174 districts, 119 cities and towns, 1,085 settlements of urban type, 11,017 rural settlements and the Republic of Karakalpakstan ⁱⁱⁱ.

After the Soviet Union collapsing the Uzbek government created a dual system, where small, so-called dehqan farmers producing livestock and horticulture products coexisted with larger individual farms producing cotton and wheat ^{iv}. Uzbekistan’s agriculture and food production landscape today consists of a smaller number of clusters (462), private farmers (132,000), dehqan farmers (4.7 mln) and household owners (5.5 mln) ^{v xiii}. Out of farms that were recently established according to the Cabinet of Ministry Decree of 2019, 25,437 are cotton-grain, 4,047 are vegetable-gardening, 8,674 are vegetable-grain, 22,301 are horticulture, 10,084 are livestock and 9,591 others ^{xiv}.

The land size of different producer categories is regulated by the government.

Table 5. Minimum land size of different farm categories

Type of farm	Land size, ha
Cotton growers	100
Grain-vegetable farms	20
Vegetable-gardening farms	5
Horticulture-viticulture farms	Less than 10
Livestock farms	Depends on the livestock heads

(Source: Ministry of Agriculture of Uzbekistan)

The fruit farms that were captured by the current study survey had a high range of a farm size from 0.6 - 47 hectares (on average 12.5 ha).

To make the farms more stable and resilient the government highly support their diversification though combination of different production activities. In 2019, 11,939 farms were transformed into multi sectoral. Besides the primary agricultural production, the modern processing and packaging system has been developed.

Clusters. The government is taking steps to reduce the state involvement in the production of cotton. Currently, it is introducing vertically integrated cotton clusters as pilot programs, in which farmers are contracted by local textile enterprises to sell their produced cotton. The cluster model envisages the creation of integrated production cycle domestically – from production of raw cotton to processing of ready textile products with high added value. Clusters are oriented towards the implementation of modern technologies, innovative approaches, efficient forms of organization of production and labor. In the framework of the cluster system, textile enterprises invest in the agriculture, both in money and technology. Ferghana Valley has several locations where aggregation and clustering are already taking place and not only in terms of cotton and textile clusters, which already get significant financing ^v. Clusters are oriented towards the implementation of modern technologies, innovative approaches, efficient forms of organization of production and labor.

Box 1 - Cotton Cluster

The cluster model envisages the creation of integrated production cycle domestically – from production of raw cotton to processing of ready textile products with high added value. In the framework of the cotton cluster system, textile enterprises invest in the agriculture, both in money and technology. Ferghana Valley has several locations where aggregation and clustering are already taking place and not only in terms of cotton and textile clusters, which already get significant financing ^{iv}.

Main tasks of clusters are ^{xv}:

5. implementation of the newest scientific technologies and efficient methods of growing of cotton;
6. efficient management of subordinate lands and distribution of state funding;
7. Implementation of efficient and profitable methods of processing;
8. production, preparation and sale of sowing cotton in accordance with the requirements of state and international standards;
9. introduction of advanced agrotechnical and water-saving technology;
10. organization of processing of raw materials and production of competitive products through attracting direct investments, as well as loans from international financial institutions;
11. widespread incorporation of modern ICT in the processes of accounting and control over the quality and quantity of the products;
12. research in the field of seed selection, production, etc. in cooperation with scientific and educational institutions.

More clusters beyond primary cotton production are developing in such sectors as horticulture with niche products such as raspberry or pistachios ^v. There are 146 horticultural clusters with the total land volume of 112.5 hectares ^{xiii}.

Dehqan households. 70% of Uzbekistan's agricultural output comes from the dehqan households ^{xvi}. These farms produce 56% of all crops, including more than 65% of all the country's horticultural crop. Dehqan farms are created based on household plots. The head of the dehqan farm receives a land plot for life inheritance. Unlike farms, the maximum size of the land plot is set for dehqans: 0.35 hectares of irrigated land, 0.5 hectares of rainfed lands, and no more than 1 hectare of non-irrigated land in the steppe zone. These are small farms focused on self-sufficiency and selling surplus agricultural products in food markets. Dehqan farms have some advantages compared with large farms: unrestricted production and marketing choice, stronger tenure security and higher crop productivity. The small size of dehqan farms makes them flexible and efficient on the one hand but on the other hand also makes it difficult to integrate them into modern horticulture value chains that demand quality, reliability, safety, and traceability.

Dehqan farms are partially commercial and partially subsistence farms. While they occupy only 13% of arable land in the country, dehqan farms produce almost 70% of the country's agricultural output as well as a large share of its fruit and vegetables and dairy products as they dominate horticulture and livestock sub-sectors. Although, dehqan farms are operating more efficiently than larger farms in using land and labor and by producing more profitable and less water-demanding products, their small size hinders them to generate sufficient volumes of outputs. This does not allow them to reduce transaction costs for marketing and improving the quality of their products ^{viii}.

Dehqan farmers cannot expand their irrigated land beyond the maximum 0.35 hectares, set in the Land Code. Absence of a legally recognized market for irrigated land is a major challenge for dehqan farms. Apart from emerging informal land transactions, the only way for dehqan farms to enlarge their land size is by accessing low-quality rain-fed land (up to 2 ha). Dehqan farms co-exist with large farmers. Large farms operate an average land size of 15 hectares accessed through a long-term (10-15 years) lease arrangement with the State. Dehqan farms have stronger tenure security relative to the State controlled large farms. They receive land from the local authority without any State obligation and they are exempted from State ordered land reforms. Dehqan farms have much higher average productivity of a hectare of land than large farms. For instance, the wheat yield on dehqan farms was 6 tons/ha in 2016, while it was 4.8 tons/ha on large farms. More so, compared with large farms, dehqan farms have higher productivity for high value crops like vegetables and fruits. In 2016, the total value of crop output per hectare of land on dehqan farms was UZS 29 mln (about USD 3,000), while it was UZS 4.5 mln (USD 500,00) on large farms ^{vii}. In 2018, dehqan farms produced 88% of total volume of potatoes, 74% of vegetables, 61% of melons, 63% of fruits and berries, and 55% of grapes.

Dehqan farms are run by experienced family members, at a low transaction cost. Dehqan family members typically have additional farm and/or non-farm jobs, besides their small farmland. Mostly, they are engaged in seasonal on-farm employment by large farms, and



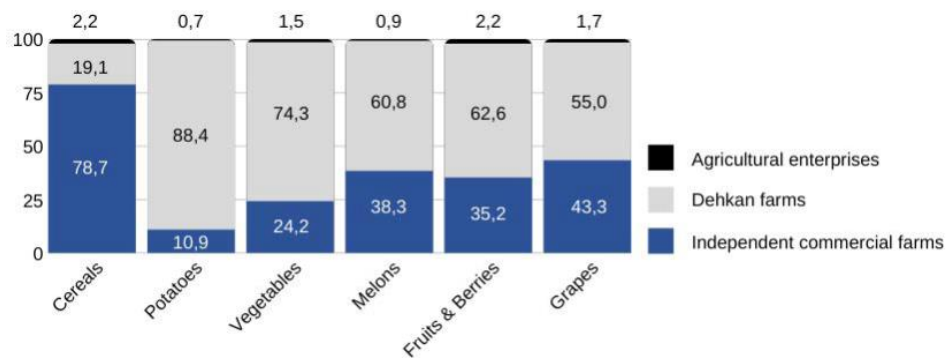
particularly in cotton picking. Such a mix of small farm and extra seasonal work sustains the small farms with multiple incomes. Dehqan farms are a sustainable part of the social and cultural setting of the rural community. Their social capital enables them harness local agricultural knowledge and remain resilient to crisis. Dehqan farms rarely get the opportunity to enhance their farming skills and knowledge, with exceptions of some projects providing technical support. Dehqans have limited access to farm demonstrations on modern and improved agricultural practices and technologies. Online resources and advisory services relevant for these farms are also scarce and dehqan farms are less likely to use digital technology. Thus, their labor tends to be low-skilled and manual. Similarly, active groups for collective learning and participatory knowledge sharing are not well developed, or at an infant stage. Dehqan farms are increasingly challenged by family members outmigration.

Table 6. The productivity potential in dehqan farms in comparison with the world, t/ha, l/day ^{iv}

Product	Average yield in Uzbekistan, t/ha	Max yield in the world, t/ha	Yield gap, t/ha
Wheat	6	16.8 (New Zealand)	11
Corn	10	12.5 (Chile)	2.5
Rice	5	15 (China)	10
Potato	34	46 (Netherlands)	12
Grape	15.5	30 (India)	15
Cow milk	6 l per day	20 l per day (South Africa, Israel)	14

Dehqan farmers are among the 75% of the country’s rural poor. Their living standard is constrained due to the little public attention given to solve their challenges identified earlier including smallness of farms, access to modern knowledge, technology, services, improved inputs and output markets. The agricultural development Strategy for 2020-2030 recognizes the challenges of Dehqan farmers and acknowledges the importance of improving their production, marketing efficiency and livelihoods. Networks and partnerships with large farms should also be strengthened. Experiences around the world demonstrate that such partnerships have potential to facilitate access to inputs, services, capacity development opportunities, and markets. Inclusive agricultural service cooperatives also have potential to provide an important market function for Dehqan farms. Such voluntary cooperatives could/do facilitate joint machinery use, irrigation water use, output marketing, credit and saving as well as purchase of inputs. More than 30 **agricultural cooperatives** are reported to be established in 4 regions in 2019, following the adoption of the Presidential Decree № 4239 “On measures for the development of agricultural cooperation in the horticulture industry” ^{xvi}.

Figure 3. Crop production by farm types in 2018 (stat.uz)



In 2018, 110,000 low-income families were provided with fruit trees, vegetables seedlings and crop seeds. To improve the financial situation of low-income families, 69,000 farms were attached to 1.5 million private households, the light greenhouses were built in 73,200 households^{xiv}.

2.2 Farmers’ interest to agricultural insurance

The importance and high necessity of agricultural insurance in Uzbekistan is admitted by all stakeholders who were contacted during the feasibility study. The MoA and Ministry of Finance (MoF) are collaborating with each other to implement strategical steps towards agricultural insurance support and further development. This includes the subsidy for agriculture insurance premium in 2022 and the intention to draft the agricultural insurance law.

The farmers perceive a high risk for their agricultural production and clearly see the necessity of introducing measures for risk mitigation. However, they are reluctant to opt agricultural insurance as tool for risk mitigation, having mentioned that previous experience with agricultural insurance was not satisfactory due to highly complicated loss adjustment process and high ratio of loss payment declines due to insufficient insurers’ standards. However, being informed about a potential future transparent agriculture insurance system with simplified loss handling process farmers expressed the desire to learn more and indicated that they potentially would buy agricultural insurance cover with the price of 5-7% of the insured crop value in average, in most cases opting the price 5% of the insured crop value.

The risks that the farmers would like to cover for their orchards are:

- spring frost
- winter frost
- drought
- high summer temperature
- strong wind
- pests and diseases

In more rare cases farmers would like also to cover hail, heavy rain, flood, theft, hot wind. Farmers would like to cover by insurance equally their production expenses and the future yield.

The farmers undoubtedly have needs and interest in agricultural insurance. However, for many farmers insurance will be an unfamiliar concept with unclear mechanism. The insurers in collaboration with the government will need to organise a proper campaign to generate farmers' motivation in buying insurance and understanding the details of its operation.

CHAPTER 3 – IRRIGATION SYSTEM IN UZBEKISTAN

Water resources of Uzbekistan are part of the water flow in the Aral Sea basin. The total average long-term annual flow of all rivers in the Aral see basin amounts to around 116,2 km³/year, 67% of which is formed in the basin of the Amudarya River, 33% - in the basin of the Syrdarya River. Also, total groundwater reserve in the Aral see basin equal to 31,17 billion m³. Amu Darya basin – covers 81.5% of the country. The entire main Amu Darya River can be divided into three reaches: the upper reach borders Afghanistan and Tajikistan, where most of the water flow is generated; the middle reach first borders Uzbekistan and Afghanistan and then enters Turkmenistan; and the lower reach, in Uzbekistan, before the river discharges into the Aral Sea. Syr Darya basin – covers 13.5% of the country. The entire main Syr Darya River can be divided into three reaches: the upper is in Kyrgyzstan, where most of the water flow is generated; the middle in Uzbekistan and Tajikistan; and the lower reach in Kazakhstan, before it discharges into the Aral Sea. The main tributaries within Uzbekistan are the Chirchik and Akhangaran Rivers, which rise in Kyrgyzstan.

In 1992, the Interstate Commission for Water Coordination (ICWC) was established out of respective Ministries and the newly independent republics decided, with the Agreement of 18 February 1992, to prepare a regional water strategy and continue to respect the existing principles until the adoption of a new water sharing agreement. This new agreement was confirmed by the 'Agreement on joint actions to address the problem of the Aral Sea and socio- economic development of the Aral Sea basin', which was signed by the Heads of the five states in 1996. The Commission is having regular annual meeting when the terms of the Agreement are updated. Over the years, the ICWC has achieved the conflict-free supply of water to all water users, despite the complexities and variations of dry and wet years. The estimated average surface runoff from upstream countries is as follows:

- Amu Darya basin: Based on an agreement between Uzbekistan and Turkmenistan signed in January 1996, which supplemented the '1992 Five Central Asia Countries Agreement', half of the water is allocated to Uzbekistan and half to Turkmenistan. Thus, of the average flow of 44 km³/year, 22 km³/year are reserved for Uzbekistan and 22 km³/year for Turkmenistan (of which 0.68 km³/year are Turkmenistan's IRSWR). This means that of the 43.32 km³/year allocated flow from the Amu Darya River basin from Tajikistan into Uzbekistan, 21.32 km³/year is transit flow to Turkmenistan.
- Syr Darya basin: 22.33 km³/year from Kyrgyzstan, of which 11.8 km³/year is transit flow to Tajikistan, of which 11.54 km³/year again is transit flow to Uzbekistan, of which finally 10 km³/year is reserved for Kazakhstan.

Providing high importance of irrigation in Uzbekistan, a separate government organisation – the Ministry of Water Resources (MWR) - is regulating the water delivery and distribution in the country. While MWR has been responsible for this sector at government and inter-government level there is a lower-level organisation – Water Consumers Association (WCA) – who is administrating the water delivery to the end users in the agricultural sector. Each of the territorial units (district, province) has the water quotas for production of cotton and wheat as main crops but also for horticulture as secondary crops ⁱⁱⁱ.

Surface water resources allocated to Uzbekistan are calculated every year, depending on climatic conditions and existing flows. MWR indicates some water shortage at crop vegetation stage (April to October) due to insufficient flow from upper countries and excess of water in winter when upper countries drop it from the dams. There are around 50 reservoirs in Uzbekistan with a total capacity of over 22 km³. The largest reservoirs are multipurpose dams used for irrigation, flood control and hydropower production. In recent years the annual volume of water resources used by Uzbekistan averaged 51-53 km³/year. 80% of the total volume of water resources consumed by Uzbekistan falls on the share of transnational rivers which are formed on the territory of the neighboring countries. (20) Shortage of water in rivers and dams can be caused by low precipitation, e.g. little snow in winter. This situation is observed now regularly due to the climate change. MWR is investigating and implementing the water saving technologies as a part of the climate adaptation. They support a mass installment of the drip irrigation infrastructure and improving the management of the water supply limits.

Water quotas are set at the legislative level of Uzbekistan, including for irrigated agriculture, and considers the diversity of regional conditions and needs. Irrigation in Uzbekistan relies on a system of pumps and canals, which is among the most complex in the world. In 1994, water was lifted by electric pumps to irrigate 1.17 mln hectares and there were about 1,500 pumps. The total length of the inter-farm irrigation network is 27,620 km, of which 62% is composed of earth canals, and of the intra-farm network 167,379 km, with 80% composed of earth canals. There are 25,000 hydraulic works on the main and inter-farm canals and more than 44,000 on the intra-farm network. Farmers don't pay for water but pay for the water delivery. As a whole, the number of hydraulic structures is sufficient for the main and inter-farm irrigation systems, most of them are in need of major repair or reconstruction. The reparation and reconstruction are currently covered by 6 investment projects that are financed from IMF credits.

Currently the average efficiency of the irrigation network in Uzbekistan is 0.63. It is necessary to consider the future active development of the management system of the water resources of Uzbekistan, modernization of the irrigation network, automation of water metering and water saving according to the state program 2020-2030. The efficiency of the irrigation network is expected to increase by 0.73 before 2030. Currently out of total 4.2 mln hectares of irrigated land the drip irrigation is installed on 20%, Kashkadarya has 80% coverage by drip irrigation. Till 2030, 50% of the total irrigated land should be covered by a drip irrigation equipment. Main part of the state's financing of the sector is spent on the Irrigation networks (63%) and is often aimed at the support of the production of cotton and grain crops. Implementation of the new modern water legislation in line with the European Union

Parliament's directive on water resources (2000/60/EU) will ensure the development of the necessary legal and regulatory framework to streamline future water policy and introduction of integrated water resources management methods. MWR has a project with USAID "Water and environment".

In course of the current project survey all farmers with horticultural production indicated having the irrigation system. 37% of respondents use the drip irrigation technology. 19% of respondents admitted having not full water availability during the vegetation season.

The irrigation system in Uzbekistan is a vital part for country's agricultural industry. The current infrastructure of the irrigation system is old and requires substantial reparation and modernisation as well as implementation of the new technology. The system has 2 levels of management – national and local. The end user water delivery, which is implemented by Water Consumers Association, requires more transparency and structuring. Interruption in water delivery creates a water deficiency risk for farmers. Installation of drip irrigation technology serves the water saving purpose in the condition of the climate change and water deficiency increase.

CHAPTER 4 – CHALLENGES OF THE AGRICULTURAL SECTOR

4.1 Current challenges

Water. Uzbekistan generally has risky conditions for agricultural production. With lack of natural water reservoirs and low precipitation the agricultural industry is very dependent on the irrigation system. Insufficiency of irrigation water that negatively influences also other agronomic-technological factors and leads to the yield deficiency in comparison with the planned potential ^{xvii}. Of 20.2 mln hectares of agricultural land, only 20.7% are irrigated ⁱⁱⁱ.

Nutrients. The amount of nutrients in the soil of irrigated arable lands is below average. One of the major issues in agriculture in Uzbekistan is salinization due to poor irrigation practices. More than 40% of irrigated land is saline and strongly saline. The Republic of Karakalpakstan, Bukhara, Jizzakh, Navoi, Syrdarya and Khorezm suffer most from high soil salinity levels ⁱⁱⁱ.

Data. Most agricultural producers do not have data on agrochemical soil analysis on their agricultural lands; there is no system for automatic early detection of pest and disease development on agricultural lands ^{xviii}.

Machinery. The stock of agricultural machinery and equipment is low and most of the available machinery has been used for more than 15 years; the bulk of the harvest of cotton and other agricultural crops is harvested manually.

Knowledge and extension services. Due to the use of outdated technologies and weak quality of the agricultural know-how among other factors, the productivity level in the agricultural sector remains low in Uzbekistan. In the extremely limited public investment in agricultural research (0.1% of total agricultural budget) still major share of the funds are allocated to

cotton and wheat production programs. Moreover, with very few exceptions, there are currently no organized public or private agriculture extension or agricultural advisory services in Uzbekistan. This leads to the fact that the vast majority of farmers and agriculture businesses lack access to regular, reliable information, know-how and advice to guide the development of their farms and businesses ^v.

Trading/Export. The agricultural products trading has its own challenges. Because of a lack of hard and soft infrastructure and high costs, very few firms hold the necessary certifications for exports. At present Uzbekistan appears to be poorly equipped to meet any of the three requirements found in most world markets. These three requirements are: SPS, maximum residue levels (MRL), and third-party certification. As a result, Uzbekistan is one of only 14 countries that is not a signatory to the International Plant Protection Convention (IPPC). Uzbekistan is on top of the rejection of its fresh horticulture exports by the EU, mainly caused by the high level of mycotoxins in dried fruits, which is very far more than the EU standards. Uzbekistan has not yet developed a set of standards that are compatible with Global Good Agricultural Practices (GAP). This hampers not only access to the markets outside of the CIS but also in supermarkets in the CIS countries.

Laboratories. There is a shortage of laboratories, wholesale markets and agronomic-logistic centers that meet international standards. Customs and border points are not well equipped with phytosanitary controls for horticultural products, and the legal framework for phytosanitary control is not in line with WTO standards. The National Quarantine and plant protection system needs to be harmonized with international standards. Variety testing services and the system for Plant Variety Protection needs improvement. Assistance for the modernization of the research institutes in terms of both material and technical assistance is required especially for the seed and horticulture sector ^{iv}.

Specific challenges for the horticulture sector. Historically horticulture has not been supported and adequate public services such as phytosanitary services, certification, advisory and marketing intelligence services to enter new markets are missing. Locally developed varieties have low yields and do not meet the export requirements ^{iv}.

The land that was freed from cotton production is generally suffering from poor soil structure, lack of soil organic matter, low fertility (after years of cotton/wheat cropping) and soil salinity. Vegetables and fruit crops require higher quality soil that is well structured and offers deep rooting potential as well as high organic matter content than cotton or wheat. Both fruits and vegetables are significantly less tolerant of soil salinity than cotton, and there will be both yield and quality loss, if the quality of soils freed up from cotton is not improved and maintained. Coupled with the changing patterns of pests and diseases likely to follow the changing climate, this will require both higher and more precise inputs of agricultural chemicals into horticulture, backed up by denser, more intense, customized and regular monitoring of soil quality in order to help farmers optimizing production.

During the current project survey, the fruit farmers among their technological and infrastructural challenges admitted deficiency in resources, equipment, labor and irrigation water. Only 11% of respondents had experience (access) with the bank credits. All

respondents witnessed that they didn't receive any compensation (either from insurance or government) after experiencing the crop production losses.

4.2 Climate change

Climate change is evident in all Central Asia with Uzbekistan being no exception. In that region Uzbekistan is among the countries most vulnerable to climate change ^{xx}.

Temperature. Increase in average annual air temperatures there occurs on background of high natural variability, which is stipulated by considerable inter annual variation. Warming rates exceed the average rate observed on the global scale. The most considerable increase in average annual temperature has been observed in Tashkent and Fergana meteorological stations (1.8°C and 1.6°C respectively). On average by Uzbekistan warming rate is 0.27°C per 10 years. During the feasibility study various stakeholders described a recently observed weather pattern as “*no winter*”. During usual winter period the temperatures are not falling as before, and intensive solar radiation awakens the trees vegetation starting already from January. Till March and April, the fruit trees reach quite an advance stage of vegetation/flowering and even mild frost, moreover the snow fall, damages both fruits and trees significantly. Many farmers experienced noticeable fruits/trees losses 2 years in a row – in 2020 and 2021.

An increase in number of significant positive temperature anomalies is observed by all territory of Uzbekistan and in all year seasons. The highest rates of increase in number of days with “heat waves” have been registered in the Aral Sea littoral zone and lower reaches of Amudarya River ⁱⁱⁱ. Average annual temperature has been increasing since the 1950s by 0.27°C every 10 years. The duration of vegetation period is also increasing in average by 3 days per year. Precipitation has gradually decreased throughout 1950–2013, with the strongest changes observed in the south of Uzbekistan. Heat waves have been registered in all parts of the country, with the highest growing numbers of affected days in the delta of the Amu Darya. Throughout 2011–2016 droughts exacerbated by heat waves were registered every year. The current spatial distribution of heat during the growing season will change too: with time, the Tashkent oblast can gradually reach the conditions of the Kashkadarya and later of the Surkhandarya oblasts, while conditions in mountainous areas will come close to those currently typical of Uzbekistan's plainland.

By 2021–2040 the increase in the sum of effective temperatures is expected to exceed their natural variability by the factor of 1.5 – 2. Under the extreme Greenhouse Gas (GHG) emission scenario, by 2050 the sum of effective temperatures above 5°C may increase there by 21%, and with 15°C baseline – by 34% compared to the base period. Already by 2030 in many regions, especially in the south of Uzbekistan, climate conditions may reach critical level for the currently grown crops, which will experience thermal stress from extremely high temperatures exacerbated by the increasing moisture deficit. One can also expect the gradual shifting, towards earlier parts of the spring and later parts of the autumn, of dates when average daily air temperature passes 5°C, 10°C and 15°C. However, within Uzbekistan's plainland up to 2041–2060, the length of the growing season may stay within the range of its current natural variability. Compared to the 1950s, the growing season in Uzbekistan currently starts earlier and ends later, its duration increasing by 3 days every 10 years.

Precipitation. Analysis of change in the total annual precipitation amount averaged by various parts of Uzbekistan for the period 1950-2013 indicates very low trends towards decrease. The most significant trend towards decrease in total annual precipitation amount is observed in the southern plains of Uzbekistan (Bukhara and Kashkadarya provinces) ⁱⁱⁱ.

Glaciation. Glaciation of the mountainous area in the whole Aral Sea has great importance for the water resources of Uzbekistan. However, within the country's territory glaciations area is not too large. Rates of glaciation area decrease vary by territory and time from 0.1% to 1.65% per year ⁱⁱⁱ.

Moisture deficit (the difference between evaporation / evapotranspiration and precipitation) is expected to increase throughout the country under all GHG emission scenarios, and a 11%-14% increase is expected against the base period by 2021–2040. By 2041–2060, it is expected to stay within 17% according to the soft scenario, but may exceed 30% under the extreme scenario, pointing to the likely aridization of climate ⁱⁱⁱ.

Water demands for irrigation and ecology are not covered. The water surface of Aral Sea was decreased from 67,000 km² (1960) to 4,000 km² (2015), and water mineralization increased by 13-14 times. It lost its ecological and economic value. Deficiency of water resources will be increased considerable in the conditions of climate change. By 2040 even with increase in runoff of the Amudarya and Syrdarya Rivers, the total deficiency of water for irrigation in Uzbekistan may be 8%. With the unchanged and decreased rivers runoff water deficiency may reach 15.4% and 33.5% respectively ⁱⁱⁱ.

Even without climate change, increases in non-agricultural demands for water will cause shortages in the next decades. With climate change, certain areas, particularly basins in the western part of the country, will face severe water shortages. In agriculture the increasing moisture deficit will lead to increased demand for irrigation, while the actual shortage of water may cause water stress among crops and therefore decrease yield.

Three climate change stressors will thus combine to yield an overall negative impact on crop yields throughout Uzbekistan: i) the direct effect of temperature and precipitation changes on crops; ii) the increased irrigation demand required to maintain even reduced yields, and iii) the decline in water supply associated with higher evaporation and lower rainfall.

As a direct effect of climate changes – not considering water availability – will be a reduction by 2050 in yields of irrigated crops, including cotton, wheat, apples, tomatoes, and potatoes, by about 1% – 13% across all agroecological zones of Uzbekistan. By 2050, climate change can also improve yields of some crops provided that sufficient irrigation water is available. However, water shortages could severely limit the availability of irrigation water: when their effects are considered, climate change has a much greater negative effect on almost all crops in almost all river basins, with yield reduction of 10% – 25% through 2050 ⁱⁱⁱ.

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expect the gradual shifting, towards earlier parts of the spring and later parts of the autumn, of dates when average daily air temperature passes 5°C, 10°C and 15°C. However, within Uzbekistan’s plainland up to 2041 – 2060, the length of the growing season may stay within the range of its current natural variability.

For fruit and vegetables included in the World Bank’s study (apples, potatoes and tomatoes), even assuming no shortage of irrigation water, yields are forecast to decline about 1% – 9% under the medium scenario. Furthermore, according to East Fruit – a big local trader - the accelerating pace of climate change in recent years has the greatest impact on the fruit and vegetable industry, resulting in multibillion-dollar losses for fruit growers and winegrowers ^{vii}.

Summary of climate change features:

- Increase of temperature variability and fluctuation;
- Spring frost increase;
- Increase of heat waves and crop thermal stress;
- Redistribution of precipitation, increase of moisture deficit;
- Decrease of glaciation area that feeds irrigation;
- Increase of irrigation deficit.

4.3 Agricultural risks

Risks of agricultural production were discussed with all country stakeholders during the project mission. **The most significant risks for horticulture are spring frost, irrigation deficiency and summer heat waves.** Farmers are also naming pests and diseases as a substantial problem. The damaging effect of temperatures – too low or too high – are usually fortified by the strong wind. The measured temperature in combination with the strong wind is felt biologically much stronger and cause much deeper damage. Most of the horticultural production is in Fergana valley (Fergana, Andijan, Namangan oblasts), which has milder temperature fluctuation in comparison with other Uzbek regions (Djizzakh, Samarkand, Tashkent oblasts). For example, in March 2022 the Fergana valley didn’t experience the snow fall while it was observed in Djizzakh and Samarkand regions. The spring frost in 2021 killed up to 90% of fruit trees and 15% vines in Tashkent and Samarkand oblasts, while the farmers in Fergana valley still harvested a decent number of fruits and grapes.

Experts of *Uzagrosugurta* – the state agricultural insurer - shared the following agricultural risk definitions that are used for all crops insurance purpose:

1. hail with the diameter 6-19 mm;
2. strong wind with the speed above 25 m/s;
3. mudflow because of intensive rainfall, snow melting and mountain lakes rupture
4. fire on standing crop/field, and
5. frost (herpes in local abbreviation) – lowering of air and soil temperature to 0°C in period of crop vegetation.

Other risks that are covered by *Uzagrosugurta* for wheat and cotton are heavy rainfall, drought, extreme soil moisture, heavy snow, dried rivers (canals), flooding and plant diseases.

The current feasibility study gives a special focus to fruits and vegetables risk profile. Fruit growing is the most sensitive to climate change segment of agribusiness. Any deviations in temperature from the norm during the year lead to a decrease in yield or quality of fruits, and sometimes to the loss of trees and shrubs. Fruits' current and especially future production is also increasingly threatened by aridity and scarcity of water. Specific impacts of the climate change are manifested through short-term or long-lasting severe weather (frost, warm/cold winters, heat waves, persistent droughts) as well as through more fundamental shifts of seasons, phenology, productivity, and agroecological conditions.

Uzhydromet's (Hydrometeorological Center of Uzbekistan) systematic records of damage to fruit and vegetable plantations from extreme weather during the last decade registered multiple damage episodes during each year on the record. The largest number of cases has been registered in the Tashkent, the Jizzakh and the Kashkadarya oblasts. There has been no consistent correlation in the past 30 years between the growing horticultural output and yield on the one hand, and different changing climatic conditions on the other hand.

One of the greatest dangers for fruit growers and winegrowers is spring frosts – in just a few hours, a frost can wipe out all efforts and deprive a grower of his annual income. Even abnormally low temperatures in winter and too high temperatures in summer can cause serious damage to farmers growing fruits, berries, grapes and nuts. Frosts in early spring could affect the harvest of early carrots, and dry and hot summers could not but reduce the yield of mid-ripening and late-ripening carrots. Early frosts in autumn often cause significant damage, too ^{vii}.

In 2021 the weather presented unpleasant surprises for growers in Uzbekistan. The unusually warm weather at the end of January caused a too early awakening of nature – almonds, apricots and cherries blossomed in the southern and central part of Uzbekistan in the 2-4 weeks of February. Such anomalous warming increased the likelihood of a sharp cold snap or frost at the beginning of spring. On February 27, the air temperatures dropped to -5°C in the afternoon and -9°C at night. This weather lasted 2-3 days, and it was enough to ruin the flowers on the trees. On March 13, a new cold cyclone came from the north. On March 14, the air temperature dropped sharply throughout the country, with the exception of the Fergana Valley. In Karakalpakstan, Khorezm, some areas of Navoi and Samarkand regions, snowfall and strong wind even caused damage to power lines. As a result, the stone fruit harvest in the central and middle zone of the country was again hit by the second frost ^{vii}.

Cold waves in winter and spring have caused also significant damage to horticulture. During the famous wave of November 1954, when the temperature dropped from 6°C to -20°C over two days, fruit trees died over most of the country. In recent years, 15%-30% yield losses have resulted from night frost and early flowering of fruit trees followed by snowfall.

Considerable increase in the number of days per year with temperature above 35°C, harmful to agricultural crops, has been observed during the last 70 years. Currently the number of such days per year is on average about 80 in the south, 60 in the north and more than 40 in the

central and the piedmont areas. The sums of effective temperatures above 5°C, 10°C and 15°C have been increasing too, respectively, by 68°C, 53°C and 38°C every 10 years.

Local apple and pear farmers have been facing problems with **fire blight** (*Erwinia amylovora*) and **late blight** (*Phytophthora*)^{vii}.

As described in this chapter the agricultural industry in Uzbekistan has a big range of challenges and risks. Some of them are related to the current conditions of agricultural and social infrastructure, others – to weather events and changing climate. The list of the risks damaging crops includes following:

- spring frost;
- cold waves;
- heavy snow;
- irrigation deficiency, drought;
- summer heatwaves;
- strong wind;
- hail;
- mudflow;
- fire;
- heavy rain;
- flood;
- crop pests and diseases.

Despite the local experience of *Uzagrosugurta* in insuring agricultural risks, it seems that risk understanding, classification and definition requires further improvement. Special attention requires those risks that are originating from both components – subjective and objective – like, for example, irrigation deficiency. The future fruits and vegetables insurance project should crystalize the insurability of risks with the social component.

CHAPTER 5 – INSURANCE

5.1 Legislation status quo and improvements

Regulation of agricultural insurance consists of lawful documents from 3 sectors: general (civil), financial (insurance) and agricultural. At the moment the list of such documents includes the following:^{xvii xiii}

- i) Civil code of Uzbekistan
- ii) Insurance Law of Uzbekistan of 5.04.2002
- iii) President Decree on Agrosugurta foundation of 25.02.1997
- iv) Cabinet of Ministries Decree on Uzagrosugurta activity N125 of 6.03.1997
- v) Cabinet of Ministries Decree on further insurance market development N413 of 27.11.2002
- vi) Provision by the Ministry of Finance and Central Bank on subsidized loans for cotton and gain producers supplying for the state procurements N1675 of 14.04.2007

- vii) Law of Uzbekistan “About dehqan households” ZRU-680, 02.04.2021
- viii) President Decree “About the strategy of new Uzbekistan development for 2022-2026”
- ix) Cabinet of Ministries Decree “About livestock insurance” N830, 30.09.2019
- x) Cabinet of Ministries Decree “About the state financial support of agricultural production”
- xi) President Decree “About family business development in horticulture and viticulture” PP-20, 24.11.2021
- xii) President Decree “About the state support for horticulture and clusters development” PP-52, 15.12.2021

The existing regulation has a range of imperfections. For example, the current tax system doesn't allow to the insurance premium refund by the tax return mechanism. Unlike in other countries the insurance premium in Uzbekistan is paid out of company profit, which is unfavorable for insurance companies. There is a necessity to set up the rules/regulations for all objects of agricultural insurance through the agricultural insurance law ^{xvii}.

The MoF through the Insurance Market Development Agency (IMDA) is planning the optimization of agricultural insurance regulation. As was indicated by the colleagues of the IMDA a range of optimization measurement are planned. Among them also a support for agricultural insurance in the form of regulative documents and state subsidy for the insurance premium.

Besides subsidizing the agricultural insurance premium or payouts the state can also provide the following help:

- Financing the actuarial calculations;
- Support the new products development;
- Financing the trainings for agricultural producers and insurance experts;
- Organizing awareness and informational campaign;
- Starting capital for national catastrophic reinsurance fund;
- Development of a national weather monitoring system;
- Provide insurers with access to statistical data;
- Developing procedures for crop monitoring and loss assessment.

There is a big range of actions for general insurance market development in Uzbekistan. The MoF via its representative Ishmetov T. issued information on development of the draft Law of the Republic of Uzbekistan “On insurance activities” in the new edition, which includes the following:

- definition of basic concepts in the field of insurance (insurance rate, premium, cost, amount, payment, deductible, etc.);
- determination of the foundations of state protection of rights and legitimate interests, as well as the rights and obligations of consumers of insurance services;
- features and procedure for organizing mutual insurance, co-insurance, reinsurance and insurance pool;

- requirement to create insurance companies in the form of a joint stock company;
- further improvement of the system of implementation and regulation of the activities of professional participants in the insurance market, considering international insurance practices;
- empowerment of the authorized state body, as well as the introduction of prudential regulatory methods, modern mechanisms of corporate governance in the insurance sector;
- clarification of the features and mechanisms for the termination of the insurer's license, its cancellation, as well as the procedure for transferring the insurance portfolio or insurance obligations under insurance contracts to other insurance organizations;
- legal framework and mechanisms for the provision of electronic types of insurance services, including online insurance;
- features of electronic data interchange between professional participants of the insurance market and government agencies in the field of insurance;
- qualification requirements for the head and chief accountant of professional participants in the insurance market and their separate divisions.

Regarding agricultural insurance the MoF established an interdepartmental commission, which worked on the terms for the insurance claims budget subsidy under insurance *Uzagrosugurta* JSC contracts for the future yield of raw cotton and cereal crops.

Important direction of insurance market development includes also improving the solvency standards of insurers (reinsurers) and the procedure for determining them, as well as requirements for the placement of assets and reinsurance operations of insurers (reinsurers), which includes ^{xix}:

- the development of certain provisions on the solvency of insurers in the general and life insurance sectors, taking into account the basic principles of insurance and the standards of the International Association of Insurance Supervisors;
- the procedure for calculating the capital adequacy ratio of insurers and reinsurers, as well as a system for monitoring its compliance with insurers (reinsurers);
- improvement of asset quality assurance mechanisms;
- revision downward of the maximum amount of insurance obligations transferred for reinsurance outside the republic, for each separate insurance (reinsurance) agreement, considering best foreign practice.

Existing legislation in Uzbekistan has certain gaps in regulation of agricultural insurance. These gaps will be fulfilled gradually along with insurance practice improvement and better development of the technical side of agricultural insurance. Currently only the experts from *Uzagrosugurta* are capable to draft the regulating documents. More expanded international experience and analysis is needed for improvement of internal regulation, which, hopefully will be brought by the future development project.

5.2 Insurance industry in Uzbekistan

Uzbekistan is consistently implementing reforms/measures to create favorable conditions for the further development of the financial market, expanding the coverage of the population with high-quality financial services, supporting the activities of insurance organizations, as well as protecting the rights and legitimate interests of consumers in this area. At the same time, at the present stage of reforms, the active development of financial services aimed at ensuring stable economic growth, improving the quality and standard of living of the population, determines the strengthening of the role of the insurance market and the widespread use of insurance instruments in the republic. Reforming and ensuring the dynamic development of the national insurance market, introduction of new demanded types of insurance services, increase consumer confidence in the insurance market was a part of the State Program in 2017 – 2021 ^v.

The insurance industry in Uzbekistan used to be supervised by the State Insurance Supervisory Inspection Department – Gosstrakhnadzor. As a result of reforms, the Insurance Market Development Agency (IMDA) under the MoF was established based on the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No 1060 dated December 31, 2019. Now the IMDA is the authorized state body for regulation and development of the insurance market, ensuring the protection of the rights and legitimate interests of all participants in the insurance relationship. Today, one of the most important tasks for the Agency is the formation of a modern insurance system, improving the legal and regulatory framework in the field, increasing the effectiveness of financial and monetary policy, as well as increasing the reliability of insurance activities.

Currently 36 insurers are licensed and operate in the Uzbek market, 28 of which offer non-life and 8 life insurance services. The majority (82%) of insurance programs are voluntary, only 18% are obligatory. Insurance business in Uzbekistan include such lines as various types of liability insurance (driver, professional, employer), property, construction, cargo, financial (credit), medical, accident and agricultural. In 2021 the market insurance premium reached UZS 3.7 trillion (or USD 325.7 mln). Gross Insurance LLC, Uzbekinvest EISK JSC, Uzagrosugurta JSC, Euroasia Insurance JV and Kafolat Insurance Company JSC are leading in terms of insurance premium income.

Table 7. Top 10 insurance companies with the result as of 31.12.2021 (Uzstat)

No	Insurance company	Premium, mln UZS	Payouts, mln UZS
1	Uzbekinvest	385,385	89,325
2	Gross Insurance	343,817	56,209
3	Uzagrosugurta	260,975	35,349
4	Apex Insurance	229,112	35,131
5	Kafolat sugurta	223,750	33,629
6	My Insurance	185,284	96,200
7	Alfa Invest	156,314	21,289
8	Euroasia Insurance	154,390	36,080
9	Temiryo sugurta	135,316	13,162
10	Kapital sugurta	116,805	37,596

Historically the Uzbek market insurance indemnity ratio stays at a consistently low level (25-28%) in comparison with the international practice (can reach 80-90%) ^{xx}.

The insurance market requires the revision of the current standards and quality of services. Among others, the following problems in the insurance market need to be addressed ^{xix xx}:

- the refusal to pay the insurance indemnity,
- lack of an innovative approach to the provision of insurance services. The current insurance market standards are still highly based on soviet traditions and lack of international know how of the modern period,
- the definition of insurance obligations without mutual agreement with the insured,
- lack of leading management and qualified personnel in the field of insurance,
- lack of efficient and satisfactory methods of resolving insurance disputes (e.g. efficient way of negotiation before the court application),
- lack of free conclusion of insurance contracts with the insured.

The Road map on the accelerated development of the insurance market of the Republic of Uzbekistan for 2019-2020 includes the following elements ^{viii}:

- development of the draft Law of the Republic of Uzbekistan "On insurance activities" in a new edition;
- study of the prospects for introducing insurance mechanisms for imported fruit and other types of seedlings during their transportation, as well as against agricultural risks.
- Study of the current state and mechanisms of the implementation of index insurance, as well as the prospects for the introduction of this type of insurance in the agricultural sector of the republic.
- Preparation of proposals for the introduction of new types of compulsory insurance, including in the field of real estate and agricultural risks insurance, considering the interests of the state and society.

5.3 Status quo of agricultural insurance

At the moment the insurance protection and financial support of farmers and dehqan farms, which are representing the agricultural sector, is one of the strategic issues in the focus of the Uzbek government. It is regarded as an effective tool that would help mitigating financial losses from natural disasters and improving economic situation of agricultural producers ^{xx}.

Currently only large farms purchase agricultural insurance, or those that can access to bank loans, especially subsidized loans for cotton and wheat. However, access to agricultural credit for producers is limited due to absence of the credit history, liquid collateral (land cannot be accepted as collateral), lack of registers on production and sells, insufficient banking regional infrastructure. In this context agricultural insurance would facilitate such access, strengthening the farmers' financial sustainability and investment attractiveness of agricultural projects ^{xvii}.

Agricultural insurance distribution requires from an insurer a substantial regional network, which is currently present in *Uzagrosugurta* ^{xvii}. Besides *Uzagrosugurta*, 2 more insurance companies - *Gross Insurance* and *My Insurance* - were involved in agricultural insurance activities. *My Insurance* similar like *Gross Insurance* was created over 10 years ago and has 60 regional offices. The approach of both insurers' involvement was very similar to *Uzagrosugurta* – they were servicing the state procurement of cotton and grain. The practice of the state procurements is going to be cancelled now. After experiencing the high riskiness of classical agricultural insurance, insurance companies stepped out from agricultural insurance 2-3 years ago. However, insurance companies in Uzbekistan provide financial insurance for the bank credits non-payment. Agricultural producers sometimes buy such insurance and receive the insurance compensation. The credit non-payment could be caused by agricultural risks because of the crop yield loss or reduction. However, financial insurance doesn't evaluate the technical reason and parameters of the loss. This type of financial insurance exists only on the territory of the former Soviet Union.

Since 2021, *Semurg Insurance* started their activities on Uzbek market with strong emphasis on agricultural insurance and being supported by world leading reinsurers. *Semurg* has developed own rules and procedures for agricultural insurance and signed the insurance contract with Indorama – the biggest cotton cluster in Uzbekistan. In 2022, *Semurg* organized a conference on agricultural insurance with active involvement of the government stakeholders and big media resonance.

5.4 Description of *Uzagrosugurta*

Uzagrosugurta is a State joint stock insurance company (JSC) that was created in 1997 and traces its origin from Gosstrakh (Soviet only state insurance company). *Uzagrosugurta* used to be the Uzbek market leader with the market share of 14%, it was providing all risks insurance related to agriculture. The company has 206 branches and 3,000 insurance agents across the administrative divisions of Uzbekistan. SJIC "*Uzagrosugurta*" partially carries out functions of special government agency in supporting agriculture. One of areas of company's activity is monitoring crop conditions and compliance of agro-producers with agricultural technology for cultivating crops.

According to the President Decree No 6096 of 27.10.2020 "On measures for accelerated reformation of enterprises with the participation of the state and privatization of state assets" *Uzagrosugurta* has gone through transformation. The company was instructed do the following:

- by April 1, 2021 – to prepare financial statements of an enterprise for 2019-2020 based on International Financial Reporting Standards (IFRS) and submit to the Cabinet of Ministers for approval of the schedule for obtaining international credit ratings;
- by April 1, 2021 – to develop a financial recovery strategy, increase operational efficiency, as well as medium and long-term development with the involvement of reputable international consulting organizations on a competitive basis;
- by July 1, 2021 – to introduce a modern corporate governance system, which stipulates an audit of procurement and management systems, as well as the formation of "compliance system" and anti-corruption services;

- by July 1, 2021 – to staff with qualified international specialists at least 30% of the composition of the supervisory boards and at least three managerial positions in the management board of the enterprise by actively attracting foreign specialists in this field (including compatriots) to the supervisory boards on the basis of an international competition and the board of enterprises.

According to provided statistics the major crop withing *Uzagrosugurta* agricultural portfolio was cotton (up to 80%) following by wheat (up to 20%) and other crops (fruits and vegetables 2%). The cotton insurance product includes such risks as drought, hurricane, cold, hailstones, downpour, flood, wreckers, biological illnesses - the number of such risks is 18. A policyholder establishes an actual production history (APH) yield based on the grower's actual production records for 5 years. If the grower does not have 5 years of production records, an APH yield can be based on as little as 3 years of yield data. Coverage level is 50%.

According to the statistics provided by *Uzagrosugurta* during the period from 2017 till 2021 the yearly premium of *Uzagrosugurta* agricultural insurance portfolio declined from Euro 6.4 mln to 1.9 mln, the amount of insurance policies reduced accordingly from 45,109 to 178. The applicable insurance rates also demonstrated a downward trend (from 11% to 4%). The historical loss ratio of the portfolio reached 149%. Basically, for the insurer the portfolio was always unprofitable, so, the management decided to reduce the number of written policies. In the past, the state was subsidizing the *Uzagrosugurta* losses coming from agricultural insurance.

The section of fruits and vegetables insurance in the entire portfolio is insignificant. The total fruits/vegetables insurance premium for the period 2017-2021 reached Euro 51,836. In 2017 and 2018 respectively 136 and 228 fruits/vegetables insurance policies were signed. At that period the loss ratio for this section was very high – 182% and 198% respectively. To manage the loss ratio *Uzagrosugurta* reduced the number of written policies on fruits and vegetables. The overall loss ratio for the period 2017-2021 was 138% with the applied insurance rate from 2-11% (predominantly 9-10%).

Technical aspects of agricultural insurance practices could be analyzed based on the *Uzagrosugurta* **insurance terms**. Here are the key terms for cotton and grain:

Insurer: *Uzagrosugurta*

1. Premium: 4%, paid from the state subsidized loan facility
2. Sum insured: value of the future yield of cotton or on the covered area
3. Risk sharing: 80% by *Uzagrosugurta*, 20% by the state indemnity subsidy. After the losses are determined, *Uzagrosugurta* makes indemnity payment which is limited to 80% of the total yield, if the losses exceed 80% of the yield, then the rest is covered by Ministry of Finance
4. Insured events: hail, heavy rain, drought, extreme soil moisture, heavy snow, dried rivers (canals), flooding, fire, plant diseases and others.

The **timelines** of the insurance process:

Insurance contract signed and premium paid	By 1 st of February for graine, 1 st of June for cotton
Insurance policies issued	Within 3 business days after paying the insurance premium
If insurance event occurs, it is reported to the insurer via filling the event notification form	Within 10 business days from the loss occurrence
Loss adjustment committee verifies the event	Within 10 days after the loss was reported
Application for indemnity payment (a separate template) is filled by a farmer	At the end of insurance coverage period
Decision for indemnity payout	Within 15 days from the indemnity application date
Payout up to 80% of the indemnity amount by the insurer	Within 5 business days after a decision date
Decision to pay 20% by the Ministry of Finance if requested by the insurer	Within 15 days
Payout of 20% of the indemnity amount by the Ministry of Finance	Within 10 days after the decision date

When the insurance event occurs and declared, a set of certifications are required to qualify for the indemnity payments:

- Weather related events (drought, flooding, snow, etc.) to be confirmed by the state hydrometeorology services centre
- Fire to be confirmed by the Firefighting service of the Ministry of Internal Affairs
- Losses caused by non-delivery of fertilisers to be confirmed by the presence of the contract signed by a farm and a fertiliser supplier against the actual deliveries
 - 1) Certificate that commodity is fully harvested from the fields issued by the agricultural institution
 - 2) Certificate confirming the delivery of harvested commodities to the processing factories

Monitoring activities. During the entire period covered by the insurance agreement, a working group led by a deputy mayor of each region monitors the progress in the fields and submits monthly report of each inspection to *Uzagrosugurta*. Minutes of the working group certify each major process, e.g. whether soil was cultivated, fertilisers applied, irrigation is done, and so on. If any necessary activity is not performed by a farmer, a negative conclusion in the minutes may lead to cancellation of the insurance policy.

Insurance industry in Uzbekistan stays at its transformational stage. The economy liberalization and intensive reforms in all industries are also capturing the financial industry in the country. Development of agricultural insurance in Uzbekistan will require from insurers to adopt new standards and principles such as high actuarial discipline, transparent client relationship and professional portfolio management.

Such companies as Semurg, Uzagrosugurta, Gross Insurance and Uzbekinvest could support the future program of fruits and vegetables insurance by providing the entire insurance servicing infrastructure from sales and financial capital to loss adjustment.

CHAPTER 6 – FUTURE AGRICULTURE INSURANCE PROGRAM

6.1 Description of how aggregators and clusters could support insurance scale up

Using the agricultural industry aggregators as a platform for agricultural insurance promotion is an internationally known practice. Especially when insurance policies need to be delivered to the small-scale farmers some aggregated platforms/channels will be crucial. Despite the creation of clusters in Uzbekistan for farms assistance, they are not in the focus of horticulture agriculture insurance development project as they are not dealing with low-income farmers (dehqans). Clusters will play their role rather through a direct interaction with insurers, validation of insurance terms and standards, diversification of the insurance portfolios.

Private farmers and dehqan households as an insurance audience could be approached through farmer cooperatives, unions and crediting institutions. Such organisations would be motivated to deliver the insurance policies or at least relevant information under a reasonable insurance agent reward.

Many services and technological innovations are delivered to small-holder farmers through the farm cooperatives and farmers council. Among those services are micro credits, trainings on agricultural technologies and financial literacy, accounting and legal advice, Insurance will logically compliment the list of such services. Management of the Council of farmers, dehqan farms and landowners of Uzbekistan confirmed that farmers have strong needs in insurance as a risk protection mechanism. The Council is motivated to become a collective agent for agriculture insurance delivery. They would allocate their existing staff to farmers insurance education and sales, however, the Council's staff should be trained first respectively.

Quite often the agricultural input suppliers are also considered as an insurance delivery channel. At this stage it is difficult to guarantee the motivation of input suppliers in insurance sales in Uzbekistan. This will depend on the working arrangement from insurers' side. The insurance concept is not that close to input material nature. Insurance as a financial instrument is closer to other financial products, such as credits, for example. Thus, the crediting and micro-crediting institutions supported by the farmers council, international projects and banks might be more relevant for agriculture insurance distribution.

Sales of agricultural insurance especially in the beginning of the program development is a challenging task. An organisation that has already a good affinity to the farmers could be regarded as a sales platform for agricultural insurance. However, the staff of such organisation should be trained on the key features of agricultural insurance and be able to answer the insureds' questions. Good candidates for such sales platform role in Uzbekistan can be the Council of farmers and micro crediting organisations.

6.2 Overview of Ministry of Agriculture main strategy, interest in extended crop insurance, possibilities for premium subsidy support

The strategy of agricultural insurance in Uzbekistan has been discussed and implemented as a shared responsibility between the Ministry of Agriculture and Ministry of Finance (through the Agency of the insurance market development). The strategy includes the following components:

- Enhancement of the existing regulation (e.g. drafting of the agricultural insurance law);
- Expansion of the state support and implementation of new agriculture insurance mechanisms (including new insurance products);
- Insurance premium subsidy (in 2022, 50% of the insurance premium paid by the horticulture clusters and farms with export contracts is going to be compensated);
- Shift to the index insurance (at the current stage as a very general concept).

During the feasibility study meetings all stakeholders highlighted the importance of agricultural insurance development and enhancement. Perhaps, some stakeholders don't have a holistic understanding of the efficient agricultural insurance and subsequently the dimension of efforts that are required for such system establishment. There is no proactive driving force that would be connecting all components of agricultural insurance system and inspiring further development. For example, the government can allocate funding for insurance premium subsidy, however, without a conscious insurance sales and service of insurers the subsidy cannot reach agricultural producers in full dimension. The insurance companies keep conservative appetites for agricultural insurance at the current moment. It looks like the future project of horticulture insurance development will need to play a role of the locomotive and catalysator for many system components.

The Ministry of agriculture in Uzbekistan supports the concept of agricultural insurance development. The general state strategy needs to be enriched with more detailed structural components such as focus on low-income farmers, portfolio/subsidy planning, actuarial tariffication, better regulation (through underwriting and loss adjustment guidelines), training and awareness campaign. Those components will be developed along the future fruits and vegetables insurance development project.

6.3 International experience and reinsurance

Development of fruits and vegetables agricultural insurance in Uzbekistan will require an international knowledge transfer. For that purpose the experience of the countries with similar fruits/vegetables/risks profile and farm structure could be considered. The list of such countries could include Turkey, Armenia, Georgia, Kazakhstan, Azerbaijan, Israel. Turkey is an excellent role-model for public private collaboration in agricultural insurance through the state agency Tarsim as well as for the entire cycle of agricultural insurance program components. It is a dominating producer and insurer of sweet cherries and other high value fruits. On the stakeholder requests of neighbouring countries, the experts of Tarsim are sharing the technical knowledge with various countries in the region, like for example, Azerbaijan, Georgia. Armenia is a good example of very recent insurance program

development with similar crop pilot priorities - apricots and grapes. Similar to Armenia the farmers in Uzbekistan are selling a substantial volume of their products to Russian traders, thus having the same product standards and price influence. Georgia has developed a structured risk profile in accordance with crop calendar for its multiple fruit and vegetable types. Israel possess an efficient feedback system between farm unions and the state insurance fund, which enables high flexibility in the yearly insurance terms adjustment.

The international experience could be transferred through international consultants and experts from reinsurance companies as well as visits of Uzbek representatives to the countries with well-developed insurance programs. The leading reinsurance companies – Swiss Re, Axis Re, Hannover Re, SCOR – have an overview of the insurance terms and results in all countries that are practicing fruits and vegetables insurance. Reinsurers will contribute into the key assumptions for the insurance product development, insurance price calculation, validate the relevance of underwriting and loss adjustment guidelines in Uzbekistan. By supporting the development process reinsurers will be allocating their capital more confidently to the horticulture insurance program.

Collaboration of local stakeholders, international experts and reinsurers will enable the establishment of all fruits and vegetables insurance program components within 2 years. This process will also include a training process for all local representatives that will be participating in the program.

CHAPTER 7 - CONCLUSIONS

7.1 Conclusion if Uzbek farmers target group meet the farmer income requirements of the ISF project funding guidelines

The issue of the farm income and the definition of "low-income population" experienced certain challenges during the feasibility study. Farm income was discussed with all local stakeholders during the country visit. Stakeholders had difficulties in indicating the exact range of farmers income but advised that commercial farmers who are growing fruits and vegetables hardly can fall into the low-income category.

During the feasibility study we tried to derive farm income numbers from 2 sources – direct farmers witnessing during the farm survey and the statistics from the Uzbek statistical office (Uzstat). The numerical and descriptive reports of the survey is provided additionally to the report. Uzbek statistical office doesn't directly collect such financial parameter as farmers income. The best proxy that we could receive from Uzstat was the revenue from the sold fruit/vegetable products that is matched to the area planted and volume produced. We assumed that such revenue could be approximately compared to the farm income. In the Uzstat report the revenue is given only for the farms and not for dehqan households. The report for the dehqan households contains the data on the area planted and the volume of major fruits/vegetables production. We tried to apply the market price of some key fruits and vegetables to calculate the total revenue of the dehqan households as a proxy for their annual income. The revenue from Uzstat report was compared to the income nominated by farmers during the farm survey and appeared to be substantially lower.

Table 7. Revenue and income of farmers from 2 data sources

Type of farmers	Revenue from Uzstat, mln UZS	Income from a farm survey, mln UZS
Farms	236.38	651.54
Dehqan households	13.58	54.83

The income/revenue discrepancy is, most probably, explained by the fact that the farmers are not reporting 100% production figures to Uzstat. The report also indicates that the figures are representing the area/production for **major** crops (means not all). Similar discrepancy between 2 data sources is observed in the average area planted. Thus, direct evidence from the farm survey appeared to be more relevant source for farm income estimation.

According to the farm survey the average annual and daily income of different farm categories is the following:

Table 8. Farm income

	Farmers	Dehqan households
Annual farm income, mln UZS	651.54	54.83
Annual farm income, USD PPP	286,276	24,091
Daily farm income per 1 farm member, USD PPP	152.93	12.87

Similar calculations based on the Uzstat data resulted into a lower daily income, however, as already mentioned the Uzstat data appeared to be not complete. We believe that a lower income of dehqan households in comparison with farms is not related to their lower productivity rather to the smaller production scale (area). According to the farm survey the average farm size of dehqans is 0.77 hectares while of farms is 12.11 hectares.

The analysis of the data proves that the dehqan farmers fall into the category of low-income population with the income less than USD 15 PPP per day. According to the official statistics there are 4.7 mln of dehqan households in Uzbekistan. We could assume an ultimate insurance coverage for this category as 10% or 470,000 farms. The assumption for the insurance penetration among dehqan farmers should remain rather conservative as this category of producers don't have an experience with bank loans and insurance, so, the agricultural insurance mechanism will be a completely new concept for them.

The lowest income population has also lowest financial literacy being not accustomed to such professional instruments as credits and insurance. A substantial awareness and educational efforts will be needed to generate the insurance buying habits of low-income farmers. For business sustainability insurers will need to diversify their agricultural insurance portfolios by insuring farmers of different categories – clusters, commercial farms and dehqan farms.

7.2 Estimation of crop insurance market size

The structure of horticultural industry in Uzbekistan is complex. The officially existing statistics reflect the area planted by fruits and vegetables and their yield outcome only partially. For the horticulture insurance potential estimation, we used 3 sources of data: 1) result of the farmers survey, 2) Uzbek statistical office report, 3) Council of farmers report. The direct answers of the farmers appeared to be closer to the production reality, so, the farmers survey was used as source for such indexes like average size and annual income of the farm. Based on this data the overall fruits/vegetable production volume was estimated for 2 categories of producers – farmers and dehqan households. The maximum insurance market penetration estimation was made as an expert assumption: 30% for the horticulture farmers, 10% for the dehqan households. This assumption would result into 21,000 commercial farmers and 470,000 dehqan farmers being covered by insurance at the advanced stage of the program development. Besides farms and dehqan two more agricultural producer categories grow fruits and vegetables – some clusters with fruit specialisation and private households with subsistence farming. However, clusters with their high-volume production would be too far from the current project objectives of supporting the low-income population and private households would not be sensitive to financial losses, thus not motivated for buying insurance. Farmers with their annual income stand above the threshold of the low-income population. However, it is worth of including them into the insurance program along with dehqan households as they would be a better platform for insurance product development and insurance portfolio diversification.

Based on the described assumptions the total fruits/vegetables production volume for 2 farm categories would be UZS 221.93 billion (USD 19,585 mln), of which 31.12 billion (USD 2,747 mln) would be covered by insurance. If we assume the overall insurance rate 9%, then ultimate insurance premium will reach UZS 2.8 billion or approximately USD 247.2 mln. This would be a good portfolio size for horticulture subsector. But it might take 5-6 years from the first pilot to reach this estimated market potential. The horticulture insurance will be developing in parallel with commercially provided cotton/grain insurance, which collectively will be influencing the insurance standards and insurance culture among various agricultural producers.

Estimation of the future insurance market size at this stage can be done only very approximately. The future insurance program development could have many influencing factors and potential scenarios. The assumptions that underlying the initial insurance structure and size estimation will be revised after every year progress in the program development.

7.3 Assessment of the long-term viability of an extended crop insurance scheme. Indemnity based vs index insurance.

The current agricultural insurance feasibility study is focusing on the horticultural industry as a sector of low-income farmers. The future extended crop insurance scheme needs to include cotton and wheat insurance alongside insurance of economically important fruit types.

Agricultural insurance in Uzbekistan will be sustainable only when insurance companies will have diversified portfolios with different crops, insurance products and farm sizes. In the long term prospective the indemnity-based insurance coverage can be complemented by parametric products such as NDVI and/or soil moisture index for cotton and grain. However, the viability of such products needs to be investigated. NDVI index insurance coverage for cotton was developed by IAMO research institute in Germany and piloted in Uzbekistan through Gross Insurance company. This insurance program was not continued as there was not enough demand (no government subsidies). The soil moisture index insurance also could be tried for field crops (mostly cotton and grain) but the moisture dynamics model needs to be adjusted to the irrigation patterns. Such study has not been conducted yet.

Index insurance usually works better for the field crops than for horticulture as field crops have more homogenous interaction of standing crop with the environmental factor, based on which the index can be built. Theoretically spring frost could be covered by temperature index insurance. But in practice, orchards and vegetable fields are smaller and have microclimate pockets, which prevent a good correlation of the index with the crop productivity. Additionally, timing of trees/vines vegetation start varies from farm to farm and from year to year, which prevents a clear definition of the frost index coverage period. Developing a viable parametric insurance requires to have a granular yield statistic to calibrate the index, which is not accessible in Uzbekistan. The available yield statistics in the country for field crops, however, might be sufficient. The IAMO Institute was using the available statistics for validation of their NDVI product, However, the productivity structure of orchards, vineyards and vegetable fields is very complex and cannot be comprehensively reflected in the available official statistics.

Table 9. Comparison of indemnity vs parametric insurance applicability for fruits and vegetables in Uzbekistan

Feature	Indemnity insurance	Parametric insurance
Covered risks	All insurable risks, for which the probability can be estimated	Only the risks that can be described by weather parameters (temperature, precipitation, wind speed etc.)
Major risks in the coverage	Spring frost, hail, strong wind, water deficiency (on a limited basis), pests/diseases (on a limited basis).	Spring frost
Risks excluded or partly covered	Those that have too high influence of subjective factors (crop technology, water delivery decisions of the water usage association)	Pests, diseases, water non delivery, hail, wild animal intrusion, fire – should be excused as they cannot be described by weather parameters.
Insurance policy inception and termination	Has flexibility and can be adjusted to the practice of an individual farm.	Need to be fixed at the stage of the product development to account the historical data for the defined period of risk. This can increase the basis risk for the individual farm performances.

Required data	Reasonable historical statistics: crop yield, historical losses, weather events evidence. Expert’s assumptions are acceptable.	Granular historical statistics: weather parameters + crop yield at the small geographical unit. No assumptions, only factual data.
Sales process	Trained sales agents or insurer representatives.	Trained staff + robust training material as the parametric insurance concept is not immediately accepted by insureds.
Loss adjustment	Trained loss adjusters – agronomists visiting the orchards and vineyards.	The validated source of weather data that was used for initial index (parameter) calculation. Perhaps an independent organization (when the insurance company is not credible or not capable of actual loss calculation).

Considering the more heterogenous interaction of horticulture crops with environmental factors, the multitude of risks the farmers are concerned about, the small plots and many microclimates with varying patterns from year to year, and the lack of granular yield statistics, index insurance is not recommended for horticulture crops due to the high basis risk. As the farmer survey has shown, farmers do not trust the current insurance system and want to see that insurance pays out when there has been crop damage. An index product with high basis risk (and only covering one risk) would not build that trust.

Following this feasibility study, it is suggested that the IDF agricultural insurance project for Uzbekistan focuses on the product development and implementation of the insurance for fruits and vegetables. It is recommended to make it in the form of indemnity-based insurance. The initial product can be focused on 2-4 types of fruits and 2-3 regions (oblasts=provinces). For the first 2 years the insurance target audience shall consist of farmers and dehqan households in the ratio of 40/60% respectively to give a bit higher preference to the lower income producers. The insurance companies will support a new insurance program by providing insurance policies, organising trainings, sales, loss adjustment and reinsurance. After first piloting (first 2 years) the product can be gradually extended to multiple types of fruits/vegetables and regions. The indemnity-based insurance will require the field (orchards) inspections for underwriting and loss assessment by trained loss adjusters. The loss adjusters could be deployed as an internal staff of insurance companies (1-2 individuals per insurance company) or as independent experts (e.g. agronomists from agricultural entities or research institutes). The training should be done based on developed underwriting and loss adjustment guidelines with the specifics for every type of crop. The underwriting and loss adjustment guidelines could inherit existing risk estimation methodologies from *Uzagromet*, research institutes and *Uzagrosugurta*.

As it is proven by international experience, high insurance penetration cannot be reached quickly. We can foresee a gradual growth of the fruits/vegetables insurance penetration along with the products expansion, sufficient marketing campaign and perhaps in parallel with commercial cotton/grain insurance.

High necessity in risk transferring instruments in Uzbekistan is the underlying condition for long-term viability of fruit/vegetable insurance program. The most optimal form and structure of the insurance product will crystalize in the process of its development and piloting.

7.4 Recommendations for pilot crops and regions

Horticultural industry in Uzbekistan produces a wide range of fruits and vegetables. Many of them have high importance as for local consumption as for agricultural products export. There are no one-two dominating horticultural crops that could be obviously chosen as an object for priority insurance, like, for example, cotton and wheat.

The choice of the horticultural crops for the insurance pilot was analysed and discussed with stakeholders out of several parameters:

- Volume of production.
- Economic importance for internal consumption.
- Financial importance for export trading.
- Risk vulnerability.
- Agronomical complexity (further influencing the loss adjustment process).
- Gut feeling of the local experts.
- Complexity for insurance (for successful pilot, important to start with less complex fruits)

Representatives of the Ministry of Agriculture named such crops as early fruits including apples, apricots, cherries, cabbage, onion, almond, potato, nuts and grapes as those that require insurance coverage. For farmers it is difficult to choose some particular crops as they usually have mix of trees in the orchards.

The experts-agronomists advised to choose **apricots, cherries and grapes** as priority crops for the insurance pilot. These crops have high ranking for all above mentioned parameters and they coincide also with the crops named by the Ministry of Agriculture representatives.

All 3 crops – apricots, cherries and grapes – are produced all around Uzbekistan. Regions where production is most proactive are:

for apricots – Fergana, Namangan, Surkhardaria, Bukhara;

for cherries – Tashkent, Namangan, Samarkand;

for grapes – Fergana.

The local expert-agronomists advise to choose the Fergana valley with its 3 administrative oblasts – Fergana, Andijan, Namangan – as a place for the fruit's insurance pilot. Besides the fact that Fergana valley has a dense cumulation of horticulture farms, its climate is a bit smother than in other regions especially in the area near the mountains. Many donor-funded international projects from WB, ADB, FAO, GIZ, IFAD are already supporting the agricultural production development and enhancement in Fergana valley. They will create a synergy with agricultural insurance development in that region.

List of stakeholders for agricultural insurance implementation

1. Ministry of Finance
2. Ministry of Agriculture
3. Agency of insurance market development
4. Council of farmers, peasant farms and landowners of Uzbekistan

Attachments

a) Climate of Uzbekistan and weather observations

Uzbekistan has a harsh, dry continental **climate** with large daily and seasonal changes in temperature and regional differences. The country has desert, semi-arid, Mediterranean and continental climate zonesⁱⁱⁱ. Most of the territory is attributed to moderate climate zone. The southern part of the country is in the arid subtropical climate zone. Annual rainfall is below 300 mm in most locations. The country depends on its neighboring countries for its surface water supply. The main sources of water are the Amu Darya and the Syr Darya rivers which flow into the Aral Sea. Most of both river's water flow is taken for agricultural irrigation, cotton mainly, causing the Aral Sea to dry up to a fraction of its original size. Uzbekistan remains being water-stressed and vulnerable to climate change, particularly in the agricultural sector. Lakes in Uzbekistan are mainly presented by small water bodies. The large water disposal lakes were created as a part of irrigation/drainage system. There are 56 reservoirs operating in the country. Agriculture currently accounts for 90 % of the total country water intake^{iii xv}.

Yearly amount of **precipitation** on the plain is 80-200 mm, in submountain regions it is 300-400 mm and on the western and south-western slopes of mountain ranges reaches 600-800 mm falling mostly during the winter-spring period. Precipitation is mainly brought about by humid air mass. Distribution of precipitation across the territory is extremely uneven and closely associated with terrain elevation, disposition of mountain system. The significant amount of precipitation falls in autumn, winter and spring period^{xiv}.

The coldest month is January. In winter cold air mass from Arctic and Siberia regions accompanied by winds and heavy precipitation penetrates freely to far south of the Central Asia. In the northern parts of the country the **temperature** can drop to -8 degrees and lower. The absolute minimum winter air temperature of -40°C was observed on the north of Ustyurt Plateau. The hottest month is July, and in the mountainous areas - July-August. The average temperature in this period on the plain and in the submountain regions reaches 25-30 degrees, and in the south (Termez and Sherabad) it reaches 41-42°C. Air temperature exceeding 40°C is considered a dangerous phenomenon during the warm season of the year.

Because of frequent frosts between late September and April, only one crop (of cotton, grain) a year can be grown. In favorable years, however, double cropping of vegetables with a short growing period is possible. Due to the long sunny days in summer the vegetation season in Uzbekistan allows to accumulate high level of solar hours, which is favorable for the crop yield level.

The soils of Uzbekistan include typical sierozem (gray) soil (SOM=0.8-1.0%) in the northern sub-region, light colored sierozem soil (SOM=0.7-0.8%) in the central sub-region and takyr soil (SOM=0.5-0.6%) soil in the southern sub-region, also meadow, meadow-sierozem and sierozem-meadow soil types with SOM=0.5-1.0% (with low to moderate soil fertility).

The network of research facilities of **Hydrometeorological Center** of Uzbekistan (Uzhydromet) is constantly developing and enhancing. It includes: 66 meteorological stations (of which 12 are automatic) 33 agrometeorological posts, 134 hydrological posts. Meteorological,

hydrological and agrometeorological research are being conducted on the territory of the Republic since 1921. Hydrometeorological Center of Uzbekistan is a part of one of the branches of the U.N. – World Meteorological Organization (WMO). 29 stations are certified by WMO. International organizations provide their support to the modernization of the Hydrometeorological Center of Uzbekistan by supplying automatic equipment for hydrometeorological research and monitoring of the environment^{xv}. Uzhydromet collaborate with UNDP and Japanese donor on climate change projects. They contribute into a disaster risk reduction project in collaboration with GIZ and the Ministry of Emergency Situation.

The historical weather data based is digitalized. Uzhydromet makes estimations of crop damages by unfavorable weather factors as well whether forecasts which are provided to farmers upon their requests.

b) Some technical aspects of spring frost and frost protection

Advective frosts are usually accompanied by rather strong winds and clouds and can persist for quite a long time, which often negates protection efforts. Cloudiness also prevents the air and soil from warming up in the daytime and leads to the absence of temperature inversion. These frosts are the most damaging to lowland orchards because cold air accumulates and is held here longer. Accordingly, it is difficult to find a mean of protection from this type of frost. Perhaps the only relatively effective method will be over-plant irrigation, but there are many limitations and nuances here, and most producers cannot apply this method. But more on that below.

Radiative frosts are caused by the cooling of the soil due to effective radiation and are most often observed at night in clear and calm weather. Currently, the effective radiation of the earth's surface is high, and the turbulence is low, which makes it difficult to mix the cooling subsurface air layer with warmer, higher layers. This type of frost is quite common in the climatic zone of Eastern Europe and Central Asia. It is much easier for farmers to deal with this type of frost, and the effort is usually more effective. In this case, many methods with varying degrees of success can be applied.

In some cases, growers keep the plants safe even at -9°C, using these various methods of protection. Irrigation or even flooding the orchard can help protect the orchard, mainly from short-term radiative frosts, but only at temperatures no lower than 2-3°C. Even regular flooding before frost will help reduce damage by increasing humidity and temperature^{vii}.

A healthy orchard, berry plantation or vineyard always tolerates frosts better than a weakened one. Therefore, frost protection starts with strict adherence to all basic agricultural practices, from planting an orchard to caring for it. The absence of diseases and pests, balanced nutrition, correct placement of the orchard, windbreaks – all elements have a direct impact on how much of the crop will be preserved when critical temperatures come. It is necessary to remember about the reasonable selection of varieties and rootstocks when growing fruits, berries, nuts and grapes. Farmers in our region often buy seedlings in warmer countries, which either do not tolerate low temperatures in winter, or bloom too early, being affected by the waves of spring frosts. Placing the orchard, berry field or vineyard near a large

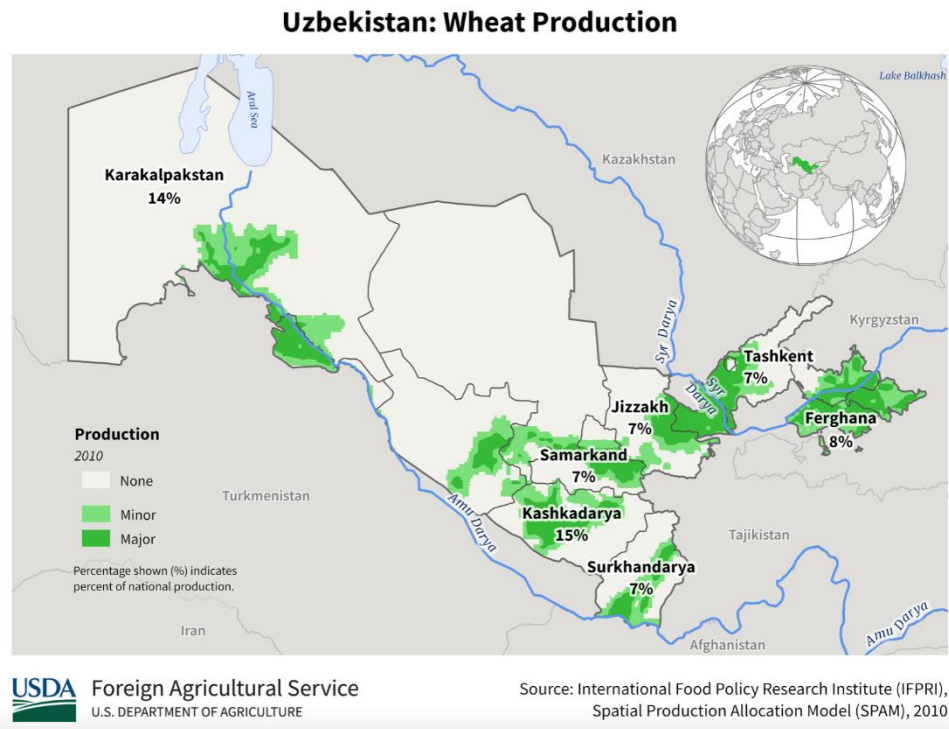
reservoir always allows to partially protect the farm from minor frosts or reduce damage from lower temperatures.

The main ways to protect orchards, vineyards and berries from frost, according to East Fruit, are ^{vii}:

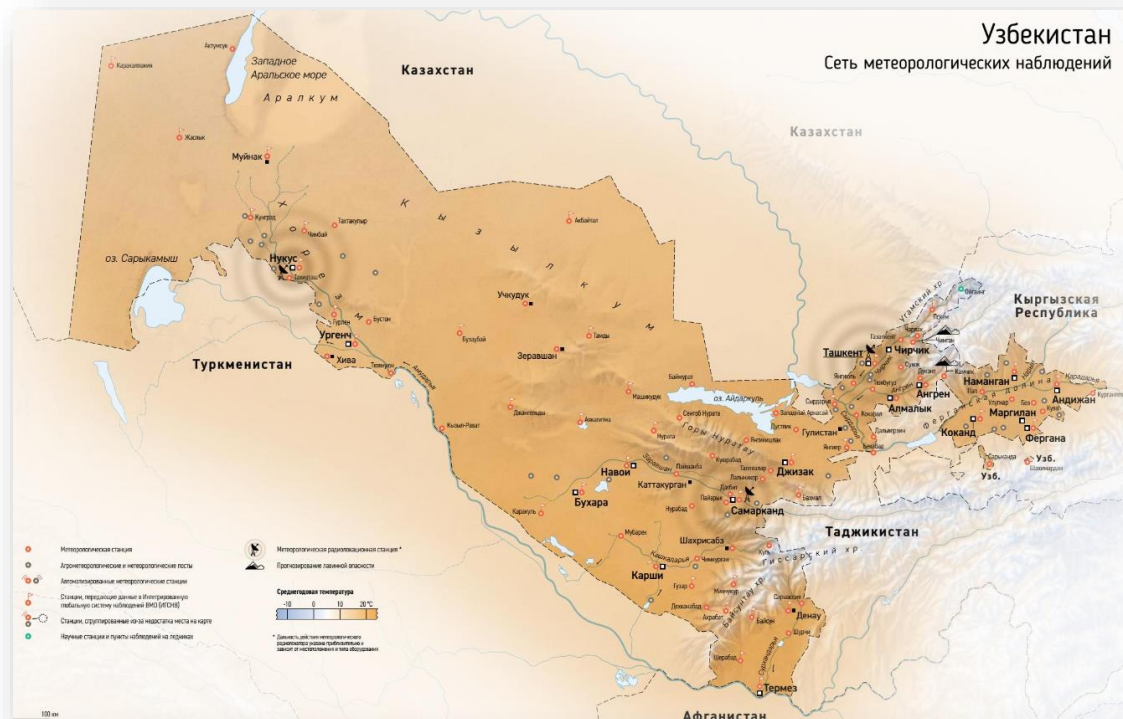
- Over-plant sprinkler irrigation (also called ice shell) is perhaps the most effective way to protect against frost, although this method, like others, has several serious limitations, which we will consider below.
- Under-tree sprinkler irrigation is like the first method, but less effective.
- Irrigation or flooding is an even less effective way to protect orchards from frost.
- Smoke is one of the most ancient frost protection methods, but is nevertheless very time-consuming, costly and limited in efficiency.
- Heating orchard is an ineffective and dangerous old method of frost protection.
- Wind machines are a versatile frost protection method that can also be used to cool the orchard during critically high summer temperatures.
- Growing under cover – obviously, this is the best way to protect against frost, but investment in it is much higher than the actual investment in the orchard or berry field itself, so we will not consider this method in this material.

Maps and figures

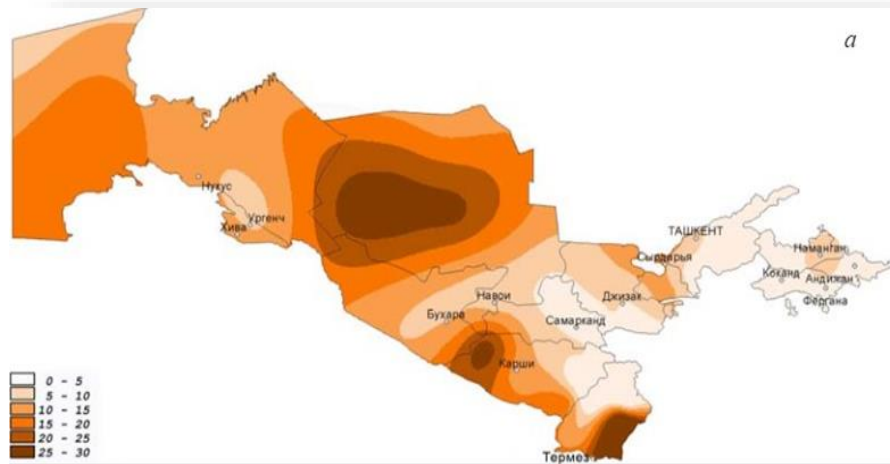
1. Regions with wheat production in Uzbekistan



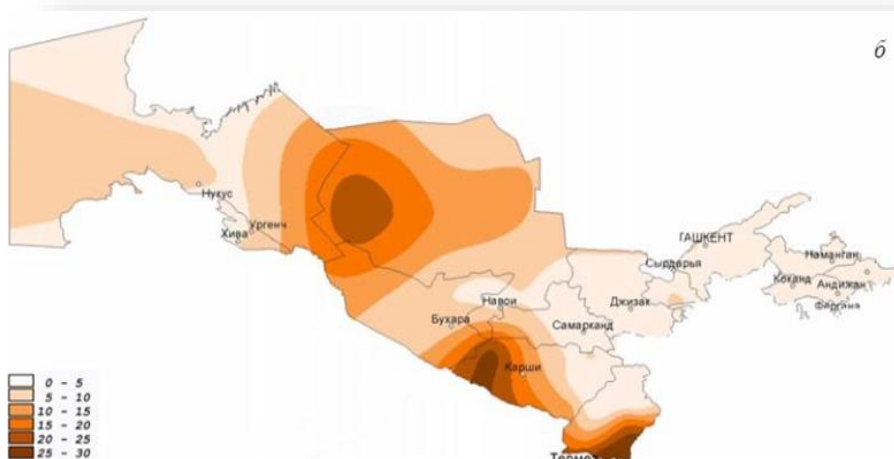
2. Meteorological observation network



3. Days with temperature exceeding 40°C (Schematic Maps of the distribution of the Number of Days with Temperatures > 40 °C in 2015.



4. Days with temperature exceeding 40°C (Schematic Maps of the distribution of the Number of Days with Temperatures > 40 ° for the period 1981-2015.



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