PhD Thesis

Mechanisms for Transition to Climate Smart Agriculture in Central Asia

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A thesis submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfilment of the Degree of Doctor of Philosophy

Budapest 2019

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Tikhonova, A. 2019. *Mechanisms for Transion to Climate Smart Agriculture in Central Asia*. Doctoral dissertation, Department of Environmental Sciences and Policy, Central European University, Budapest.

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ABSTRACT OF DISSERTATION submitted by:

Anastasia TIKHONOVA for the degree of Doctor of Philosophy and entitled *Mechanisms for transition to climate smart agriculture in Central Asia*

Month and Year of submission: September 2019

High rates of population growth in the countries of Central Asia, land degradation, water problems, shrinkage of the cropping areas, and climate change are jeopardising food security of the region. Agriculture, comprising substantial share of GDP and employing a large proportion of population in the countries of CA, requires significant transformation to climate smart practice. However, the scope of climate smart agriculture dissemination in the region remains very limited.

The methodology used included a combination of diverse qualitative research methods: expert focus group discussions, interviews with different kinds of stakeholders (ministry officials, national and international experts in the field, local administration, academia, NGOs and civil society), in-depth interviews with research institutions specialists and farmers, online questionnaire and field visits. The Kyrgyz Republic was chosen as a narrow-down focus country, were the in-depth research was conducted. The data was analysed with the help of specially developed theoretical analytical framework, combining functional and structural analysis of agricultural innovation systems.

The research identified that the main constraints to CSA adoption by Kyrgyz farmers are: lack of central initiative and willingness to support CSA; underdeveloped interactions with potential donors of CSA projects; low capacity of international actors to design the projects (including, identifying applicable CSA methods, training extension, performing evaluation and upscaling). The second level of importance gain the "infrastructural" constraints: poor financial infrastructure (scarce public funding of agricultural research and knowledge dissemination); low quality of knowledge infrastructure (research, education and knowledge dissemination on CSA); poor quality of physical infrastructure and inefficient legislative/policy framework for CSA.

The proposed solution includes creation of the system of "agro-clusters" in Kyrgyzstan, as a center-led initiative and a large transformative project, which would simultaneously address identified obstacles and enable rapid upscaling of CSA in the country.

Acknowledgements

I would like to express my enormous gratitude to the Central European University for making this research possible with its institutional help and funding support.

My special thanks to my supervisor, Ruben Mnatsakanian – for his immense help, precious advices and wise guidance during these 4 years, for giving me also freedom to be a grown-up researcher, and for the patience awaiting the results of my scientific process.

My sincere thanks to Food and Agriculture Organisation of the United Nations and Reuben Sessa for having inspired the topic of this research, and for several unique opportunities provided to collect invaluable data.

I am very grateful to Ihtiyor Bobojonov, my external supervisor, for his thoughtful advices and feedback, and for all his help, and to IAMO for hosting me for 3 months of research visit in Germany.

With a special mention to Kyrgyz experts, who in spite of their busyness dedicated a lot of time to me without hesitance. Especially to Abdybek Asanaliyev and Amanjol Atakanov for their high concernment in my data collection. I am also very grateful to the Kyrgyz farmers who opened up to me and shared their thoughts. Separate huge thanks to Kamal Rashidov for showing me his beautiful country, and to Ltd. Atalyk for being so innovative.

I am extremely thankful to my parents for giving me love every day of my life, and for all I have and I am.

And finally, to my "PhD team" for the mutual support during our frequent sushi gatherings. We made this way together!

Table of Contents

List of Tables

List of Figures

List of Abreviations

ADB – Asian Development Bank

AFP – Agriculture and Food Program

AIS – agricultural innovation systems

AKIS – agricultural knowledge and information system

CABI – Center for Agriculture and Bioscience International

CACAARI – Central Asia and the Caucasus Association of Agricultural Research Institutions

CACILM – Central Asian Initiative for Land Management

CAREC – Regional Environmental Centre for Central Asia

CCAFS – Research Program on Climate Change, Agriculture and Food Security

CCC – the Climate Change Center of the Kyrgyz Republic

CECI – Center of Education, Consultation and Innovation

CGIAR – Consultative Group on International Agricultural Research

DWRM – Department of Water Resources and Land Reclamation of the Ministry of Agriculture, Food Industry and Land Reclamation of the Kyrgyz Republic

EBRD – European Bank for Reconstruction and Development

EPF – Environmental Protection Fund

EPIC – FAO Economics and Policy Innovations for Climate Smart Agriculture

FCC – Food Contract Corporation

GACSA – Global Alliance for Climate Smart Agriculture

GCF – Green Climate Fund

GEF – Global Environmental Facility

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)

IAMO – Leibniz Institute for Agricultural Development in Transition Economies

IBC – International Business Council

ICARDA – International Center for Agricultural Research in the Dry Areas

IDB – Islamic Development Bank

IFAD – International Fund for Agricultural Development

IFPRI – International Food Policy Research Institute

ISF – irrigation service fees

Kyrgyzhydromet – the Agency for Hydrometeorology of the Ministry of Emergency Situations of the Kyrgyz Republic

NGO – non-governmental organisation

RAAIS – Rapid Appraisal of Agricultural Innovation Systems

RAS – Rural Advisory Service

R&D – research and development

SAEPF – State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic

SCPI – Sustainable intensification of crop production

SDGs – Sustainable Development Goals

SLM - sustainable land management

TIS – technological innovation system

TOT – transfer of technology

UNDP – United Nations Development Programme

UN FCCC – United Nations Framework Convention on Climate Change

USAID – US Agency for International Development

WFP – World Food Programme

WUAs – water users associations

Introduction

Unsustainable water use in agriculture during soviet times was one of the reasons, which created several problems in the region of Central Asia, including the drying-out of the Aral Sea (Glantz 2005). Land degradation, as a consequence of improper agricultural policies, is one of the main issues for the region, where 12% of irrigated land in Kyrgyzstan, 50-60% in Uzbekistan and even more than 90% of lands in Turkmenistan are now salinized (Bucknall *et al.* 2003; CAREC 2011a). It is also the cause of the shrinkage of the cropping areas, which was happening during the last years (Kariyeva and van Leeuwen 2012). Combined with uncertainties during the transition phase and extremely high rates of population growth, these problems caused high rates of poverty. According to World Bank 2009, more than 90% of the rural population in Central Asia is defined as poor (less than 4.30 USD per person per day). In some of the countries the percentage of undernourished people is extremely high, in particular, in Tajikistan it amounts to more than 35% of total population (WorldBank 2015).

Climate change adds additional dimensions to these challenges and increases the vulnerability of farmers (Lioubimtseva and Henebry 2009). Studies on climate change impacts in the region show its negative effects on the livelihoods of small-scale agricultural producers, who often lack access to financial resources and technological knowledge (World Bank 2009).

This means that agriculture has to undergo significant transformation in order to address several challenges at the same time: enhancing food security by increasing incomes and agricultural productivity and adapting to climate change. To address these challenges, food systems have to become more resource-efficient (use less inputs, water and land for more sustainable production) and more resilient to shocks, including climate-related.

These challenges are holistically addressed by the approach of Climate Smart Agriculture (CSA), the concept of which was first introduced by Food and Agriculture Organisation of the United Nations in 2010. This is an approach that incorporates all 3 pillars of sustainable development (environmental, social and economic) though complexly targeting food security and climate change issues. It includes: sustainably increasing agricultural productivity and farmers' livelihoods; adaptation and enhancing resilience to climate change; cutting on green house gas emissions, where possible (FAO 2013b).

There is no systematic effort being made for wide dissemination of climate smart agricultural practices in Central Asia. Implementation of some of them was attempted within several donor-funded projects. However, their geographic coverage is very small (FAO 2013a). Most of sustainable technological solutions were not adopted due to the absence of supporting and enabling policy environment (Bobojonov and Aw-Hassan 2013). The challenge is to understand the factors which act as constraints to adoption and wide dissemination of climate smart agriculture and to identify mechanisms which would help to up-scale these practices in the whole region (Antle and Diagana 2003).

Few efforts have been made so far to analyse the constraints to dissemination of a number of separate sustainable practices in Uzbekistan, while in other countries of Central Asia such studies are almost absent. Moreover, the climate change aspect, which started to get attention by the scientific community of the region very recently, was only addressed by a couple of scholars.

Also very little research was performed on the necessary enabling conditions, which could facilitate upscaling of sustainable agricultural practices in the region. The main attempts had very generic character, providing recommendations, which were not based on the proper analysis of the existing problems and barriers.

In general, there is a substantial lack of information, in particular, on micro crediting, land tenure, insurance and many other factors, which can be found in the literature and Internet sources. Moreover, this information in many cases is either very obscure and controversial, or is completely absent. The major part of it is available through local official websites in native and Russian languages. Often certain information (e.g. financial) is not publicly disclosed and some types of data (e.g. meteorological) are considered secret. Such information gaps can only be filled through direct interviews with national experts in the field.

The differences between the countries of Central Asia pose a significant challenge as well. Having many similarities due to common soviet past, these countries started to follow distinct development paths at some point, which eventually has led to quite different circumstances shaping the problems of today. This fact was largely underestimated by many scientists, who failed to account for path dependency and tried to find a universal solution for the whole region of Central Asia.

The aim of this research was to identify the barriers to adoption and wide dissemination of Climate Smart Agriculture (CSA) practices in the countries of Central Asia (CA), and to suggest the mechanisms for CSA up-scaling on the regional scale, in order to deliver food security and improved livelihoods for growing population in the face of climate change.

Achieving the objectives of this study required application of the comprehensive analytical framework for the analysis of agricultural innovation systems, which would allow to identify existing constraints in the system, that hamper the dissemination of CSA practices, as well as to develop an effective integrated policy instrument for addressing these constraints.

Such framework was developed by the Author of this research, after thorough analysis of the advantages and drawbacks of the analytical tools currently existing in the theoretical body of the

innovation systems theory in both "general" and "agricultural" streams. As a result, Wiezorek&Hekkert technological innovations systems framework was selected as the base for a new framework. Advantages of the combined functional-structural analysis used by Wiezorek and Hekkert; simplicity, obvious links between elements and its effects on the performance of the system and respectively agricultural problems, determined this choice.

However, the framework needed several substantial improvements for both adapting it for the use in agricultural analysis, and for improving procedures in the framework itself to achieve better quality of the analysis results, to increase convenience of its application, and to ensure the effectiveness of the selected/constructed policy instruments. The improvement made by the Author, built on advantages of existing analytical tools, allowed to produce a richer and more comprehensive analysis, and facilitated the procedure of constructing a more holistic and effective integrated policy instrument.

The following objectives were set and achieved in this study:

- ✓ To explore the situation in the countries of CA regarding adoption of CSA practices, constraints to it, and existing and potential interventions for upscaling these practices;
- ✓ To develop analytical framework for the in-depth analysis, combining the advantages of existing frameworks in the technological innovations theory and suitable for the analysis of Agricultural Innovation Systems, at the same time free of limitations of the existing AIS analytical frameworks;
- ✓ To use the developed analytical framework to analyse malfunctioning and systemic failures in the Agricultural Innovation System for CSA in Kyrgyzstan, and to develop an integrated systemic policy instrument to overcome these problems;

- ✓ In Tajikistan, Turkmenistan, Kazakhstan and Uzbekistan – to perform the analysis using simplified framework, compare the results and make a conclusion about the practical and theory added value of the research.

The following roadmap is to briefly outline the dissertation.

Chapter "Background information" provides the information on the latest baseline conditions and trends in the countries of Central Asia, describes climate conditions in the region and projections of climatic changes for the future, as well as current and anticipated impacts of climate change on agriculture in CA. It then introduces the concept of "climate smart agriculture" and presents CSA practices that were suggested for application in CA by research scholars and decision-makers. Finally, the chapter explores information available on CSA practices currently used in the CA countries, factors that were identified as constraining their adoption and potential mechanisms used globally to overcome these kinds of constraints.

Next *chapter "Theoretical framework"* first gives a short review of the evolution of innovation theory, explains the concept of Agricultural Innovation System (AIS), describes several different analytical frameworks for AIS analysis and examines their comparative advantages and limitations. Finally, the chapter provides details on the use of analytical framework developed by Wiezcorek&Hekkert that was improved by the Author to serve the analysis of AIS in general and purposes of this research in particular.

Chapter "Methodological framework" presents the combination of several qualitative methods used in this research, including online questionnaire, expert focus groups and interviews conducted during multi-stakeholder workshop, field visits and in-depth semi-structured interviews with farmers and experts during research trip, secondary data collection and policy and legislation analysis. The chapter also explains the benefits of the selected methodology.

Chapter "Results and analysis of AIS in Kyrgyzstan" shows the utilization of the developed analytical framework for combined structural and functional analysis of the agricultural innovation system of CSA in Kyrgyzstan. Performance of each function of the system is being analysed and the structural causes of failures are being identified. Based on this, the recommendations are being made in the next *chapter "Recommendations"*, in the shape of an integrated policy instrument. The developed procedure of the construction of such instrument is also explained in this chapter.

Chapter "Results for Uzbekistan, Kazakhstan, Tajikistan and Turkmenistan and discussion" summarizes the results obtained for these 4 countries. The analysis is performed without the use of the developed analytical framework (due to limited availability of data), and the simplified functional and failure analysis is used to show the mismatch between the problems identified and solutions suggested by the workshop experts. The conclusion is made about the value of the analytical framework, developed by the Author, allowing to perform in-depth analysis of the performance of AIS and to construct an efficient integrated policy solution.

Chapter "Conclusion" highlights the theory added value of this research, explains limitations of the study and provides the outlook into the future research possibilities in this area.

Background information

Central Asia – baseline conditions and trends

Countries' economy and agriculture

The region of Central Asia (CA), encompassing Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (Figure 1), experienced serious economic and social challenges after the breakdown of the Soviet Union (Paroda 2007).

Figure 1. Map of Central Asia

Source: Stratfor 2012 (www.stratfor.com)

The economies of CA countries are mainly based on agriculture (Paroda 2007). Figure 2 shows the contribution (in %) of agriculture to GDP of the countries of Central Asia by years.

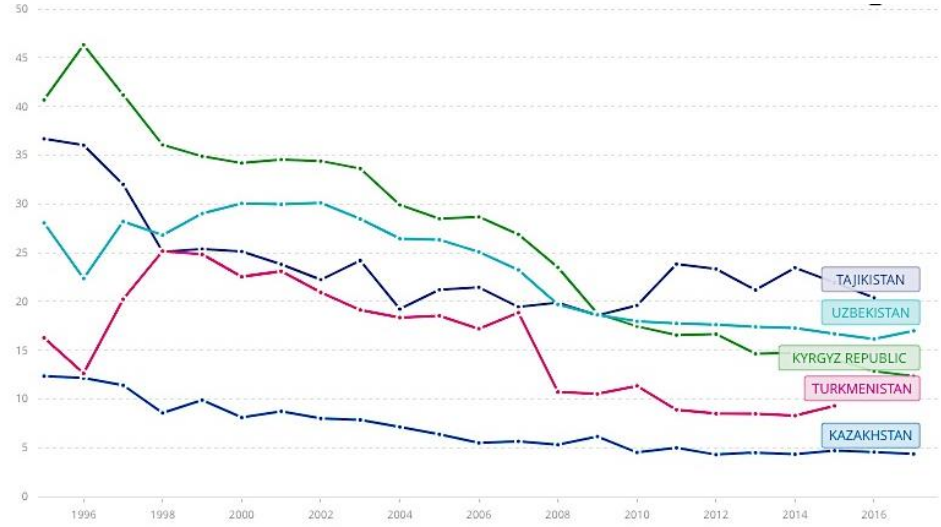


Figure 2. Share of agriculture in GDP of Central Asian countries, %

Source: World Bank 2019

Figure 3 informs about the percent of people employed in agriculture sector in Central Asian countries:

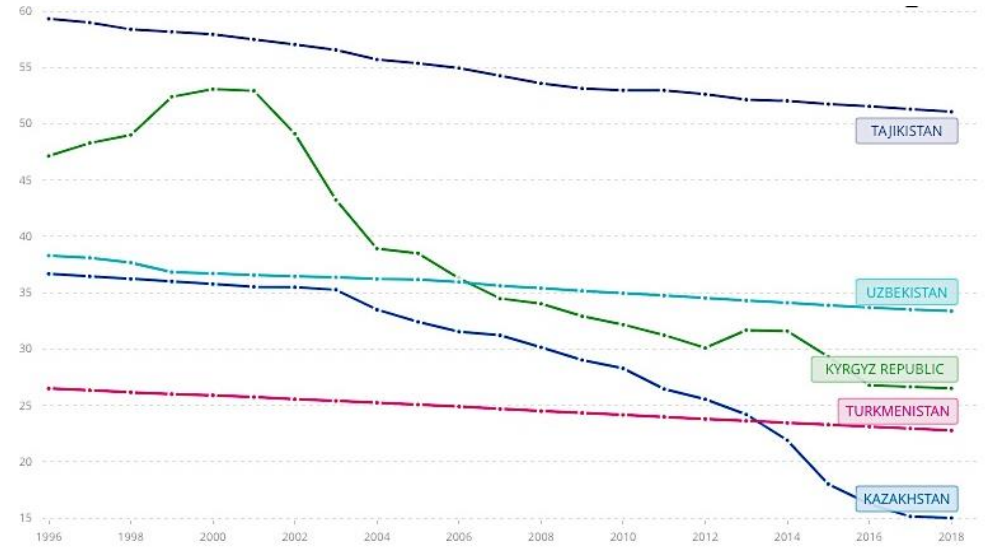


Figure 3. Percent of people employed in agriculture in Central Asian countries

Source of data: World Bank 2019

Below are presented several food security indicators: percentage of arable land equipped for irrigation (Figure 4), cereal import dependency ratio (Figure 5) and depth of the food deficit (Figure 6).

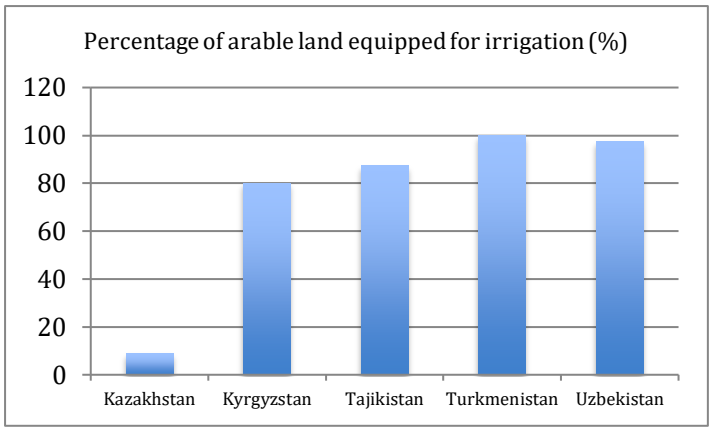
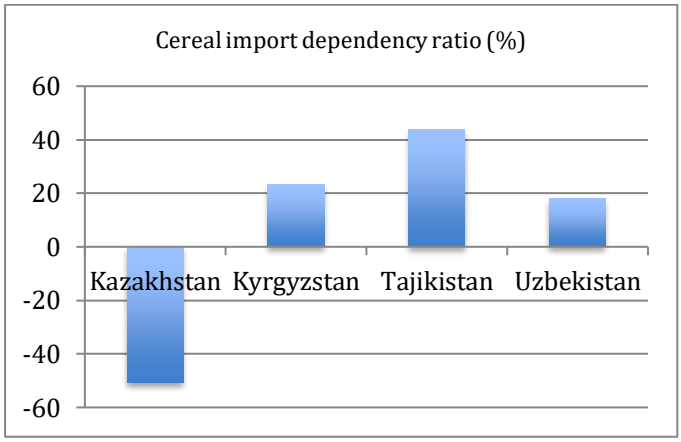


Figure 4. Percentage of arable land equipped for irrigation

Source of data: FAOSTAT 2016



** no data available for Turkmenistan*

Figure 5. Cereal import dependency ratio (%)

Source of data: FAOSTAT 2016

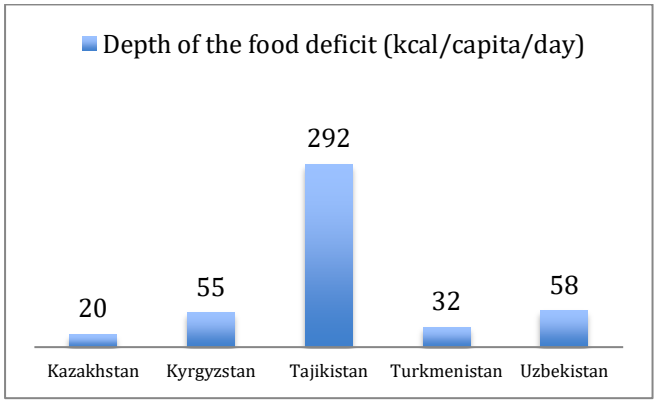


Figure 6. Depth of the food deficit

Source of data: FAOSTAT 2016

Using FAO data, the Economist Intelligence Unit has developed the Global Food Security Index covering 106 countries, including Kazakhstan, Tajikistan and Uzbekistan (Table 1). The Index reflects three food security components, each used to calculate a separate index as a composite of several parameters.

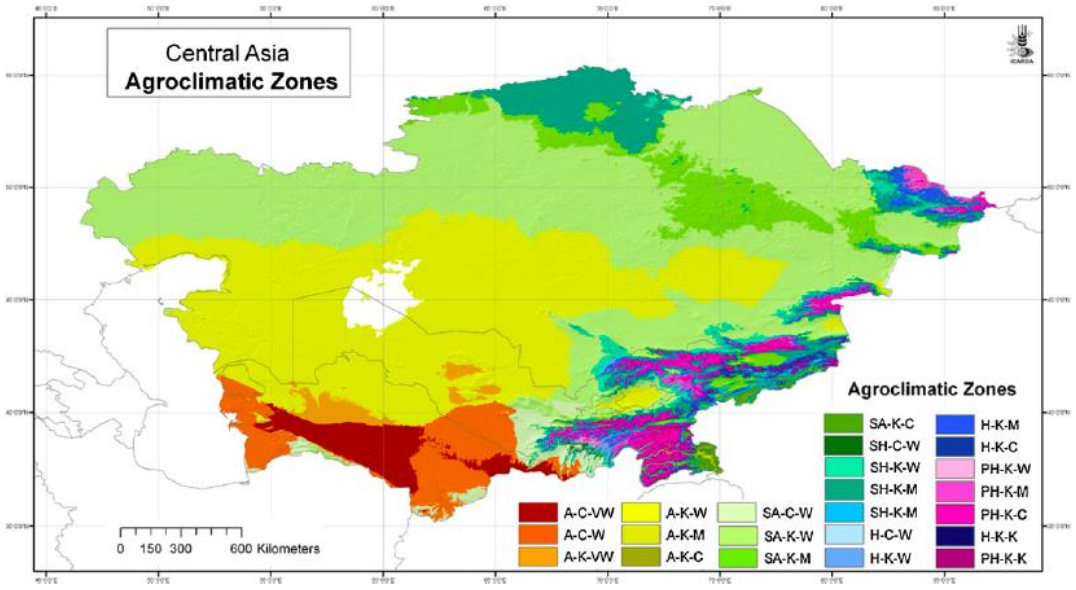
Table 1. Food Security Index for Countries in Central Asia, 2013*

Country	Overall index	Access		Food Safety
		Economic	Physical	
Kazakhstan	52,7	60,8	39,1	69,9
Tajikistan	35,0	35,5	32,8	39,5
Uzbekistan	41,6	33,0	45,9	51,5

** The higher the rank, the better the situation in the country*

Source: FAO 2014

The region can be divided into four different zones (CAREC 2011b): (i) the irrigated areas (i.e. Turkmenistan, Uzbekistan, Kyrgyzstan and Tajikistan, and southern Kazakhstan), irrigated with water from Syrdarya and Amudarya, (ii) the rainfed areas in northern Kazakhstan and in the mountain regions of Kyrgyzstan, Tajikistan, and Uzbekistan, (iii) rangeland and pastures, and (iv) small-scale subsistence agriculture in the mountain regions (mainly in Kyrgyzstan and Tajikistan) (Figure 7, Table 2).



SA-K-W – Semi-arid, cold winter, warm summer; A-K-W – Arid, cold winter, warm summer; SA-K-M – Semi-arid, cold winter; SH-K-M – Sub-humid, cold winter; A-C-W – Arid, cool winter, warm summer; A-C-VW – Arid, cool winter, very warm summer; PH-K-C – Per-humid, cold winter, cool summer; H-K-M – Humid, cold winter, mild summer; SA-C-W – Semi-arid, cool winter, warm summer; SH-K-W – Sub-humid, cold winter, warm summer; A-K-VW – Arid, cold winter, very warm summer; PH-K-M – Per-humid, cold winter; SH-K-C – Sub-humid, cold winter, cool summer; SA-K-C – Semi-arid, cold winter, cool summer; H-K-C – Humid, cold winter, cool summer; H-K-W – Humid, cold winter, warm summer; SH-C-W – Sub-humid, cool winter, warm summer; A-K-M – Arid, cold winter, mild summer; PH-K-K – Per-humid, cold winter, cold summer; PH-K-W – Per-humid, cold winter, warm summer; A-K-C – Arid, cold winter, cool summer

Figure 7. Agro-climatic zones in Central Asia with details

Source: Kienzler et al. 2012

Table 2. Salient information about the dominant cropping systems in the five Central Asian countries according to identified agro-ecological zones

Country/region	Major production system	Cropping intensity (%)	Growth period (days)	Distinguished features of the agro-ecology	Production constraints
Kazakhstan (northern parts)	Rainfed spring wheat-fallow	40-60, rainfed	210-240	Rainfed cereals, steppes, long cold winters	Drought, cold and water stress (precipitation 300-400 mm), soil erosion
Kazakhstan (southern parts)	Extensive cereal-livestock system Irrigated cotton/ wheat based systems, rice, rangelands	40-60, rainfed	30-89	Rainfed rangelands with mixed crop-livestock system, high Mg-soils, saline groundwater	Drought, cold and water stress (precipitation 250-350 mm), 12-14C, Mg-soil, soil erosion

Kyrgyzstan (Osh, Chu and Fergana Valley)	Irrigated agriculture on sloped and valley areas	40-60% or more	60-119	Sloped lands (up to 10%), supplemental irrigation, generally fresh but shallow groundwater table	Drought (precipitation 250-350 mm), 7-9C, sloped land, mechanisation Water erosion by irrigation, drainage congestion
Tajikistan (South west/NW)	Irrigated systems (cotton-wheat) Agriculture on sloped land of 5-16%	40-60% or more	60-150	Pastoral systems/ irrigated agriculture on sloping lands, saline groundwater	Drought and heat (precipitation 250-500 mm), 16-20C, salinity, water erosion
Uzbekistan (irrigated)	Irrigated cropping systems, cotton-wheat (mostly raised-bed)	More than 60%	60-119	Irrigated crop production, drainage water use, soil salinity, long growing season, double cropping	Drought and heat (precipitation 200-350 mm), 14-18C, water scarcity, salinity
Turkmenistan (irrigated)	Rainfed pastoral/ cereal production systems (mostly raised-bed)	30-60%	30-59	Crop-livestock systems, saline groundwater, overgrazing, soil salinity	Drought and heat (precipitation 200-300 mm), saline water use, 16-22C

Source: Modified from CAREC 2011b

The information about the main characteristics and farm types in five countries of Central Asia are presented in the Table 3.

Table 3. Overview of farm types and major characteristics in four of five Central Asian countries

Country	Farm type	Ownership	Number of owners	Land area
Kazakhstan	Household plots	Private land ownership with the right of inheritance	1 family	Small plots below 1 ha
	Peasant farms (individual farms)	Private land ownership on a long-term rent base from 5 to 49 years	2-3 families, or the largest up to 7 families	Small from 7 ha and large up to 250 ha
	Agricultural cooperation	Private land ownership on a long-term rent base from 49 to 99 years including limited liability and joint-stock companies	Large number up to 200 members	2000 to up to half a million ha of total land

Kyrgyzstan	Family farms (small-scale individual farms)	Private land ownership	Single family farms. Mainly livestock production	Minimum 1 ha irrigated land in mountainous, and 5 ha in non-mountainous areas
	Peasant farms: medium scale individual farms	Private land ownership	Several families. Importance of crops increases	Land area varying from 5 to 150 ha
	Agricultural cooperatives	Private land ownership	Several households or family farms that are cooperative members	Land size varying from 5000 to 87000 ha
Turkmenistan	Household plots	Private land ownership	1 family	Small plots of about ¼ ha and around 15 heads of sheep
	Family farms	Private land ownership	1 family	Variable ranging from 3 ha to 150 ha
	Private (peasant) livestock producers	Mainly sheep and camel producers	2-3 families	No arable land, no land property rights, rely on sandy used as common rangelands
	Agricultural cooperatives	Practically similar to old collective farms	Cooperative membership	Large farming units operating on vertical integration
Uzbekistan	Dehqon farms	Private ownership	1 family	0,25-1 ha with the irrigated area
	Cotton and wheat production farms	Lease contract for a maximum of 50 years	1 family	Since land consolidation reforms in 2011, ca. 100 ha in size
	Orchards and vineyards farms	Lease contract for a maximum of 50 years	1 family	Minimum 1 ha
	Livestock farms	Livestock and poultry	1 family	Size depends on the animal stock but minimum 10 ha (based on 0,33 ha per cattle unit with a minimum of 30 heads of cattle equivalents)

Source: (Kienzler et al. 2012)

Kazakhstan

During soviet times, Kazakhstan was a major exporter of grain, meat, milk and eggs to other Soviet republics, as well as cotton was exported from southern Kazakhstan. After collapse of Soviet Union, Kazakhstan undergone a serious transitional decline in agriculture almost until the end of the 1990s. Output of all agricultural products fell substantially. Large-scale livestock farming almost disappeared. During this time the government did not invest in agriculture. The share of agriculture in GDP fell from 33.9% in 1990 to only 8.4 percent in 1998 (Suleimenov and Oram 2000). Sustained growth only began since 1999 (Pomfret 2007b), agricultural sector was revitalized, with annual growth of 6-8 percent (Suleimenov and Oram 2000).

Land reform

Privatization of farms, with shares distributed among employees, was performed in 1994, but actually they were changed to cooperatives and remained under the same management. The Farm Reform of 1995 was keeping land ownership with state, but established private usage of land with long-term lease (99 years). The only small area of land which could be purchased was only in the south, were the of majority farmers were cultivating cotton (Pomfret 2007b).

In 2000, instead of the 2500 state farms which existed in 1991, there were only 89 state farms, and more than 62 000 individual farms, 8754 cooperatives, 578 joint stock enterprises and 1169 business partnerships. Non-state enterprises occupied 94 percent of all agricultural lands (Baydildina *et al.* 2000).

On 85% of land, which remained in large agricultural enterprises, was produced just 43.8 percent of agricultural output; individual farms had 15 % of land, and produced 10.2 percent of output; and individual households having virtually no land, produced 46.0 percent of agricultural output in 1997 (Suleimenov and Oram 2000).

State support

The agricultural sector was in crisis throughout the 1990s (Gray 2000). Subsidies for agriculture were reduced from 10-12 % of GDP before 1991, to 2-3 % in 1993. In February 1995, input subsidy programs were terminated and subsidized credits to agricultural producers (5 % of GDP in 1993) were abolished. The second half of the 1990s, loss-making farmers were taking non-subsidized loans, which caused further indebtedness (Pomfret 2007b).

The general price liberalization process was completed at the end of 1994. Foreign exchange surrender requirements were lifted in July 1995. In 1992, export restrictions were imposed, but were simplified in 1995 and abolished in 1996. Non-CIS markets were put in preferential position, because VAT was refunded only on exports to non-CIS markets. But this was removed in the 1997 (Pomfret 2007b).

Agriculture was not much protected by tariffs with average import-weighted tariffs equal to 18.3% for agricultural commodities. It hasn't changed substantially since 1995, but some were reduced (Pomfret 2007b).

Minimum export prices for agricultural commodities were abolished in December 1996. Registration of wheat, rice and cotton exports was abolished in 1997. But in 1999 the government introduced a price support system for wheat and then extended it to other goods (Pomfret 2007b).

The FCC (Food Contract Corporation) buys 10-17 percent of production in order to maintain grain short-term price, but as a grain exporter it is not able to move far away from world price (Pomfret 2007b).

Expenditure on agriculture was growing by 40% per year between 2000 and 2005 under the billion-dollar Agriculture and Food Program for 2003-2005 (AFP). Among the objectives of the

AFP establishing an efficient agricultural system, improving domestic and foreign markets and state support for agriculture. Many subsidies and price support schemes were provided for inputs (fertilizers, seeds and fuel) and with, some working against resource-efficiency (Pomfret 2007b).

The livestock sector was provided with subsidized livestock and breeding material, subsidies for veterinary control. Also in 2001 Mal Onimderi Korporatsiyasi (MOK) was established – a state-owned joint stock company, which received a loan of two billion tenge at an interest rate 10% lower than in a commercial line of credit. Banks offered subsidized credit to agricultural processing companies, because they were partially reimbursed for this by government. This was the cause of significant recovery in the livestock sector (Pomfret 2007b).

Uzbekistan

Uzbekistan is the most populated country in Central Asia with the largest agricultural sector. Out of 45 million ha of land, 60% is under agriculture. From this 4.3 million ha (12%) are irrigated and irrigation makes 80% of all water use in the country. Cotton and wheat are cultivated on the majority of irrigated territory (Abdullaev *et al.* 2005).

Since the breakdown of the Soviet Union, several aspects of the former central planning system continued to exist, for instance, putting quota on the area, on which cotton should be cultivated and keeping prices well below market levels (Abdullaev *et al.* 2005).

Agrarian reforms

The first policy change in agricultural sector in 1986 was allocating over 10% of total irrigated area (0.5 million hectares) for small scale production by increasing individual family plots for 1.5 million families and giving new plots to 0.5 million families (Abdullaev *et al.* 2005; Tashmanov *et al.* 2000).

The second change was made with the purpose to achieve grain self-sufficiency. A shift in production was made from cotton to wheat by expanding area under winter wheat from 620 thousand ha in 1991 to 1,2 million ha in 2004. Wheat production grew significantly from 1.0 million tons in 1991 to 5.2 million tons in 2004 and Uzbekistan is now a grain exporter (Abdullaev *et al.* 2005).

The production quota system

Before independence, quotas were imposed on the output and area of crops; state was purchasing the output and was controlling the price, as well as it was controlling the inputs.

In 1991, 100 % of all agricultural commodities had to be sold to the state, apart from those, which were cultivated on the family plots. Since 1995, state quotas were abolished for everything, except cotton and wheat. Wheat quotas are milder, farmers can sell 50% of the quota in the open market or keep it (Tashmanov *et al.* 2000). As for cotton, 100% had to be sold to the state, but the state also mandated the area which must be sown with it (Abdullaev *et al.* 2005).

Cereal production has increased due to subsidies and direct credits. This policy led to a decline in vegetable and fodder crops, which had a negative effect on livestock sector and soil quality (Schieder and Cai 2008). Farmers, at present, are not able to make independent crop choice, which poses a big constraint to sustainable agricultural development in the country (Bobojonov *et al.* 2012).

State procurement is performed at steady low prices, significantly different from world prices (Muller 2008a).

Land reform

Farm restructuring process was started in 1992 and accelerated after 1996 (Abdullaev *et al.* 2005).

In soviet times, farms were collective and large, typically 2000-3000 ha, and each managed its machinery and irrigation. During restructuring, their land was split into smaller collective farms - shirkats. The management has deteriorated as well as performance.

At the same time, in 1992 the individual farms were emerging (Abdullaev *et al.* 2005). They were farmer enterprises and the farmer households (or dehqon farms) (IAMO 2008; Djanibekov 2008a).

Shirkats were shareholding companies, members worked on the basis of individual family contracts. (Suleimenov and Oram 2000) The family was taking an obligation to produce a certain amount of production and the agricultural cooperative was obliged to purchase it at a fixed price. It also had to supply shareholders with water for irrigation and to provide machinery. (IAMO 2008) From 2003, shirkats started to be transformed by the government into individual farms. (Abdullaev *et al.* 2005) By 2006, all shirkats had disappeared (Spoor 2007/10).

The dehkon farms are legalized family plots, orchards. The land is given to the head of the family for life and may be inherited by his descendants. It should only be cultivated by the family members, external workers may not be employed. The limit of the size for dehqon farm is 0,35 ha on irrigated land, 0,5 ha on non-irrigated land or 1 ha in the steppe. (IAMO 2008) The dehkon farms can get credit and other financial support from the state. They can grow all types of crops, except cotton, and no quota is imposed on them. They can also sell production in the open market (Abdullaev *et al.* 2005).

A farmer enterprise (individual farm) is a business agricultural unit with land leased for up to 50 years but no less than 30, and headed by the founder. Livestock farms must have at least 30 animals and minimum 0.3 ha of land per livestock (2 ha in rainfed areas). Farms for cotton or grain growing must be minimum 10 ha large, and at least 1 ha for other crops. The land leased to the farm may not be privatized, sold, exchanged or donated. The farm is prescribed with specific type of production and a minimum output to be produced by the leasing contract. If this prescription is violated, the land can be taken from farm. The land might also be confiscated if it is needed for public use (IAMO 2008).

In 1998 a new land code was introduced which strengthened the security of land tenure for individual farmers. At present, farmer enterprises can lease land for 49 years. But still the land can be confiscated if the production agreements are not fulfilled 3 years in a row (Abdullaev *et al.* 2005).

Water reform

Before independence the water management was mainly territorial, because of this equitable water distribution was never fulfilled (Abdullaev *et al.* 2005).

Since 1991, part of the operation and management costs was put on water users with creation of water users associations (WUAs) and introduction of water charges. Water distribution order and equity has deteriorated with division of former large farms into multiple small ones. In 2003 basin water management principle was introduced (Abdullaev *et al.* 2005).

State support

In 2007, the growth of agriculture was high and stable (6.1%) due to strong state support to agriculture and use of incentives like preferential financing, tax preferences, improvement of

infrastructure, advancing agricultural equipment and implementation of scientific research results (Dukhovny *et al.* 2011).

In 2004 the major taxes used were producer price controls with farm gate prices substantially lower than export prices, value added tax on cotton fiber (not reimbursed for export), and excise taxes on cotton seed crushing for oil production. Among main subsidies in 2004 were subsidies for operation and maintenance of the irrigation system, interest rate subsidies on state credits for agricultural producers and debt write-offs (Guadagni *et al.* 2005).

Kyrgyzstan

It is considered that the Kyrgyz Republic is the most advanced among Central Asian countries in conducting reforms and economy stabilization. And it was the first to obtain membership in the World Trade organisation in 1998 (Kitamura 2008).

Land and agrarian reforms have as an objective developing a market economy and giving agricultural producers economic and decision-making independence, privatizing of state and collective property and the creating competitive market infrastructure and relations. Agriculture contains various types of farms. In 2000, more than 52 thousand farms were registered, including 22 thousand farming enterprises and 30 thousand peasant farms. Also, 335 cooperatives, 281 collective-peasant farms, 45 joint stock companies, and 53 state farms were created. This had a positive economic impact and caused an income growth in agricultural sector (Tashmanov *et al.* 2000).

Kyrgyzstan conducted the same reforms as Kazakhstan, but the results were much better, because of different scales and farming types. For instance, before the reform, there were no large-scale state farms, farms in Kyrgyzstan were relatively small. That's why during the reform they were easily divided into individual farm units, 10 ha each, without such negative consequences as were

in Kazakhstan. And proportion of such farms in Kyrgyzstan is significantly higher (Suleimenov and Oram 2000). This land reform was conducted in the 1990s and presently Kyrgyz agriculture is completely privatized (Sehring 2007).

Unlike in Uzbekistan, where livestock sector doesn't receive any subsidies from the government and share of individual farms in livestock production is minor, individual farms in Kyrgyzstan are provided with some state support and have the highest share in livestock production (Suleimenov and Oram 2000).

According to Tashmanov *et al.* 2000, the main results of the agrarian reforms in Kyrgyzstan were: substantial changes in land ownership, an increased share of the rural community owning land; decentralized competitive markets; diversification of cropping patterns with more profitable crops, like tobacco and vegetables; beginning of formation of financial and credit institutions; shift to stable agricultural growth.

Water reform

Several water reforms were performed in the Kyrgyz Republic. A new Water Code was approved in 2005. A reform of irrigation management is conducted to make it efficient, market-oriented and decentralized. The main steps are the establishment of Water User Associations (WUAs) and the introduction of irrigation service fees (ISF).

ISF were first introduced in 1995, but only been realized in 1999. It is argued that ISF in Kyrgyzstan have just a symbolic meaning because of a widespread non-payment. Also farmers are allowed to pay 30% of it in kind, but in reality 50-80% are paid in this way (Sehring 2007).

Development of WUAs started in the middle of 1990s, first of them were established by the government of Kyrgyzstan. Later the wide spreading of WUAs was conducted with the help of

World Bank and ADB projects. Donor organisations were putting a condition of creating of WUAs in order to access to international funding for the rehabilitation of agricultural infrastructure (Sehring 2007).

In year 2000 a WUA support department was established in the Ministry of Agriculture and Water Management with branches in all provinces and districts of the republic. In 2006 the "Law on Water User Associations" was adopted and by 2004, around 60% of the irrigated land in Kyrgyzstan was under management of 353 WUAs (Sehring 2007).

But so far the reform didn't achieve much success (Sehring 2007). The problem according to Sehring 2007 is that new formal rules are not perceived as legitimate and are being contested by informal rules. Also WUAs were not created as new institutions, but rather incorporated in existing ones with former societal and political structures: they are managed by the head of local government or by his deputies (Sehring 2007).

Tajikistan

Land reform

Since 1990 a legislative base was prepared for conducting land reform in Tajikistan. This reform aimed to transfer land and property of state agricultural enterprises to collective farms and to restructure these farms. In 1993 the government adopted a Resolution in order to draw less qualitative land to agricultural production. By 1999, 10 thousand individual farms were established on 716 thousand ha of land, leasing enterprises were created on the basis of 35 farming units. Apart from that, 358 collective farms, 9 interfarm units and 33 agricultural cooperatives were established (Tashmanov *et al.* 2000).

Despite conducting the land reform, state production plans and control still exist in Tajikistan. As a result, high poverty rates and subsistence agriculture are dominating in the country. There is

virtually no cash transfer in the agricultural economy, almost all economic transactions are barter deals, the sector is de-capitalized (Tashmanov *et al.* 2000).

Water reform

In Tajikistan a new Water Code was approved in 2000. Administrative re-organization was realized to a lesser degree than in Kyrgyzstan (Sehring 2007).

The first project on creation of Water User Associations (WUAs) in Tajikistan was led by the World Bank in 1999. Around 100 WUAs now exist in Tajikistan, managing just about 1/5 of the irrigated territory (Sehring 2007).

In 1996 it was decided to introduce irrigation service fees. But the reform was unsuccessful. Sehring 2007 claims, that while the government of Tajikistan have reduced budget allocations for operation and maintenance of irrigation by 50% since the introduction of those fees, the situation with payments of ISF is even worse than in Kyrgyzstan. This causes gradual deterioration of irrigation infrastructure.

Turkmenistan

Land reform

In Turkmenistan the land reform and land privatization was started in 1995 with the establishment of first dehkon farms. Land privatization was performed gradually, with the majority of farms being leased for long term and inherited by family members (Aganov *et al.* 2015).

At present, agricultural production is performed on several types of farms: dehkon farms, which are legalized independent farms; agricultural enterprises and people's farms, which are private farming units, collective orchards and yards (Baydildina *et al.* 2000).

Water reform

Around 90-95% of water in the country is used for irrigation (Baydildina *et al.* 2000).

Turkmenistan is the only country in Central Asia, which is inactive in conducting water reform and developing policy towards integrated water resource management in spite of the recognized necessity of it (CAREC 2011b).

Agrarian reforms

The main objectives of agrarian reforms in Turkmenistan are enhancing the role of the private sector, increasing resource use efficiency and land productivity (Baydildina *et al.* 2000).

Food security policy was conducted to achieve food self-sufficiency. With this purpose, in 1994 a new subsidized fund for agricultural development was created for giving credit to agricultural producers. Since 1996, Dekhkanbank and its branches, the Pagtabank and the Gallabank, are providing agricultural credit from the budget on a promotional basis. These banks are just receiving small fees for giving out credits and collecting payments. But it is planned to transform them into real financial intermediaries (Baydildina *et al.* 2000).

In 1999, taxes on agricultural commodities were temporarily removed to enhance production and export. In the period 1991 – 1998, Turkmenistan shifted from hard dependence on grain imports to self-sufficiency in main agricultural goods (Baydildina *et al.* 2000).

Population growth trends and projections in Central Asia

Demographic trends for Central Asia are showing a steady increase in population numbers over the past years (Lutz 2010).

The main reasons for that are substantial share of young people and currently quite high level of fertility. In 2007 fertility rate was the highest for Tajikistan (3.4), followed by 2.9 in

Turkmenistan and Kyrgyzstan, 2.7 in Uzbekistan and 2.5 in Kazakhstan. According to Lutz 2010, fertility in the countries of Central Asia is going to fall, approaching the end of the process of demographic transition. However, the speed of decline is still unclear and population growth is already preprogrammed to sharply increase in the nearest 100 years.

According to WorldBank 2015 (Figure 8), population in Central Asia will increase by 60-80% by 2050.

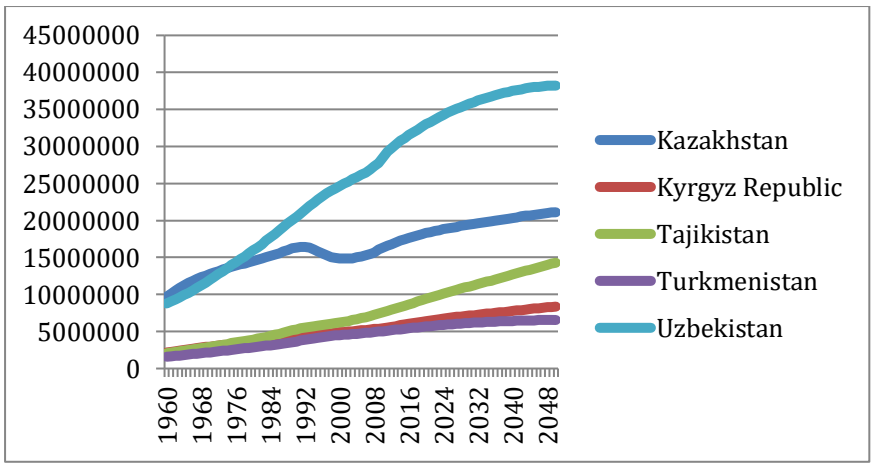


Figure 8. Population growth trends and projections for countries of Central Asia

Source: WorldBank 2015

The IIASA projections for Central Asia show an increase from currently 63 million to 95 million in 2050, 103 million in 2075 and 101 million in 2100. Uncertainty about the fertility trends causes substantial range of possible numbers; for instance, in 2100 projections vary between 72 million to 133 million people. But there is no doubt that population of Central Asia will continue its huge growth over the coming decades (Lutz 2010).

Climate change in Central Asia – projections, vulnerabilities and impacts

Climate projections and vulnerability of agriculture in Central Asia to climate change

The climate of Central Asia is projected to become warmer and much more arid, especially in the west of Kazakhstan, Uzbekistan and Turkmenistan (Lioubimtseva and Henebry, 2009). It is possible that for some small areas this change might be beneficial, in particular by longer growing season and a slightly increased winter temperatures and precipitation in northern and eastern Kazakhstan), but the majority of the region will be negatively affected - frequent droughts and decreased precipitation are expected to impact crop production and increase already extremely high irrigation water. It will further exacerbate environmental issues in the region and might pose threat to food security.

The recent World Bank report on Adapting to Climate Change in Europe and Central Asia (WorldBank 2009) developed a series of indices to assess the exposure, sensitivity and adaptive capacity of countries to climate change. The vulnerability index displayed in Figure 9 is a combination of the exposure, sensitivity and adaptive capacity indices.

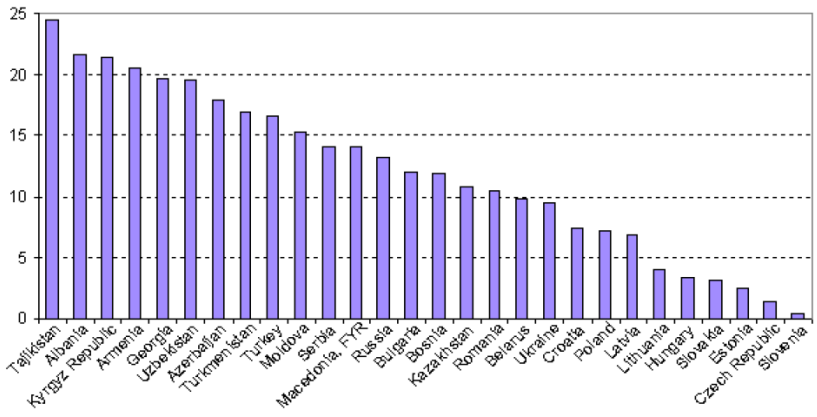


Figure 9. Climate Change Vulnerability Index, ECA Region

Source: Adapting to Climate Change in Europe and Central Asia (WorldBank 2009)

Kazakhstan

Vulnerability assessment from the III-IV National Communication of Kazakhstan to the UN FCCC (Kazakhstan 2013) show, that because arid zones are projected to shift to the north of the country, the area of cultivation of spring crops will shrink. In some regions cost-effectiveness of crop cultivation will become doubtful.

Forecasts show that in projected climate in 2030 yield of spring wheat will decrease by 23-33 % and until 2050 crop yields will drop by 37- 48%.

By 2030 productivity of grassland on lowland pastures in the south will decline by 3-4%. By 2050, it will further decrease by 10-14%. As mountain pastures are more vulnerable to climate change, for them productivity decline will be more substantial – by 30% in 2030, and by almost 50% in 2050.

The amount of non-grazing days in the south of Kazakhstan in 2030 will drop by 15%, and in 2050 – by 28%. The heat increase by 2030 and 2050 is projected to negatively impact productivity of sheep (Kazakhstan 2013).

Uzbekistan

Figure 10 displays nine climate change vulnerability indicators. Agriculture of Uzbekistan is more vulnerable to climate change than European and Central Asian mean value for the majority of indicators (WorldBank 2010).

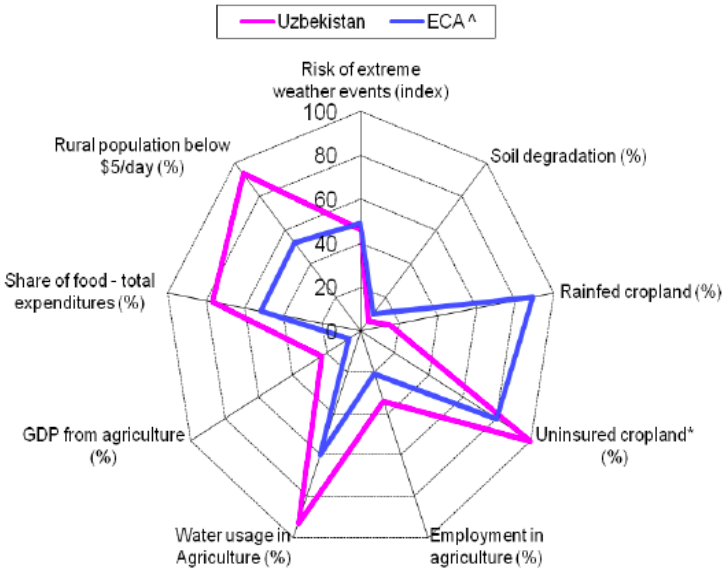


Figure 10. Uzbekistan Vulnerability Indicators

Source: WorldBank 2010

Vulnerability assessment presented in Uzbekistan's 2d National Communication under UN FCCC (Uzbekistan 2008) shows following main conclusions:

- Decline of cotton yield due to evaporation increase are expected to be from 4% by 2030 to 10% by 2050, winter wheat – from 2% by 2030 to 4% by 2050. Moreover, yield decrease for majority of crops in extreme years may achieve 14%;
- By 2050 the decrease of yield will reach 11-13% for cotton and 5-7% for wheat in the Syrdarya River Basin; 13-23% for cotton and 10-14% for wheat in The Amudarya River Basin;
- In some arid years yield losses in The Syrdarya River Basin may achieve 15-17% by 2050, and 17-28% in The Amudarya River Basin;
- Heat stress on Astrakhan sheep by 2030 increases by 2-7%, growing 5-11% more by 2050, and 8-18% by 2080 (Uzbekistan 2008).

Kyrgyzstan

IFAD Summary report on Climate Change Impact on Pastures and Livestock Systems conducted for Kyrgyzstan (IFAD 2013) identified several levels of vulnerability for different districts of the country, which are shown on the Figure 11.

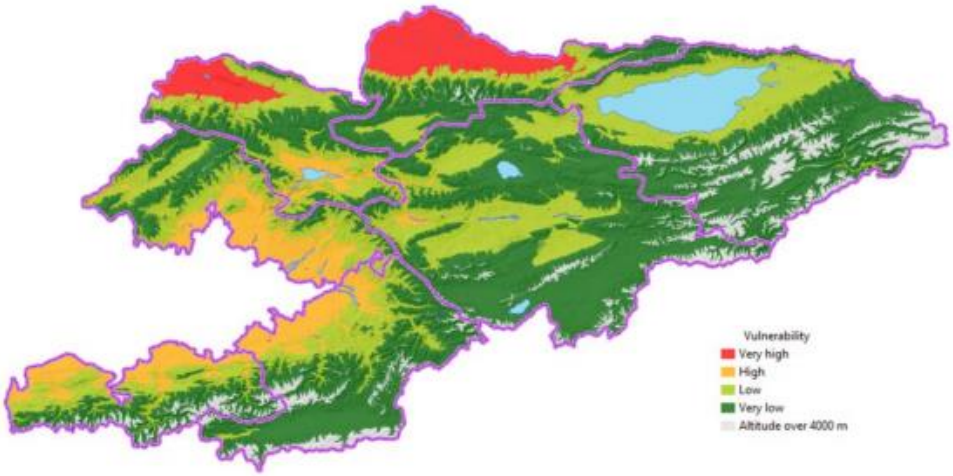


Figure 11. Levels of vulnerability to climate change in Kyrgyzstan

Source: IFAD 2013

According to the vulnerability assessment conducted for (Kyrgyzstan 2009a), the following conclusions were made:

- The assessments of crops productivity change till year 2100 for all regions of Kyrgyzstan are presented in the *Table 4*.

Table 4. Assessment of productivity change of the main agriculture crops till year 2100 in some provinces of Kyrgyzstan

Province	Melons	Grapes	Potatoes	Corn	Vegetables	Fruits	Wheat	Rice	Sugar	Tobacco	Cotton	Barley
Batken		-		-	-	-		+		0	+	
Jalal-Abad	+	0		-	+	+	0	+		+	0	

Issyk-Kul			0		-	0	0					0
Naryn			+		+		+					+
Osh	0	0		0	0	+	0	0		0	0	
Talas				+	+	+	-					-
Chui	+	-	0	0	0	-	-		-			0

Legend: "+" – growth of productivity, "-" – reduction, "0" – no significant changes

Source: (Kyrgyzstan 2009a)

- As it follows from the productivity projections for pastures, climate change is generally favorable to the growth of pasture vegetation (*Table 5*).

Table 5. Assessment of pastures productivity change till year 2100 for various types of pasture vegetation in Kyrgyzstan

Province	Echinata	Koboezy	Stipa type	Gramineous herb meadow	Syndow-gramineous	Syndow	Bluegrass	Sedge	Artemisia-halophytic	Artemisia-grameneous	Artemisia-ephemeral	Artemisia	Ptilagrostistisy	Cauch-grass-sedgy	Cauch-grass	Steppe-andropogon-rtemisia	Fescue-Bluegrass-Herbal	Fescue	Barley type
Batken			+						-		+				+	-			-
Jalal-Abad							+				+					+		+	
Issyk-Kul		0	+			+		-					+					+	
Naryn		+						+		-		+						+	
Osh	+		-								+				+			+	+
Talas			-				+		+		+							+	
Chui		+		+	0									-		+	+		

Source: (Kyrgyzstan 2009a)

Tajikistan

According to Barbone *et al.* 2010, rising temperatures will cause 20% decline in winter-spring pasture productivity. According to (Shah *et al.* 2013), in high mountain pastures, the same rise can lead to an increase of pasture productivity by 25 – 50%.

Vulnerability assessments were conducted for 19 zones by WFP based upon only four parameters, and for 10 agro-climatic zones by the World Bank (Heltberg and Bonch-Osmolovskiy 2011). The combined vulnerability is shown on the Figure 12. The hatched area illustrates the most food insecure areas based upon WFP Food Security Monitoring System from Oct 2008 to Aug 2010 (Wolfgramm *et al.* 2011).

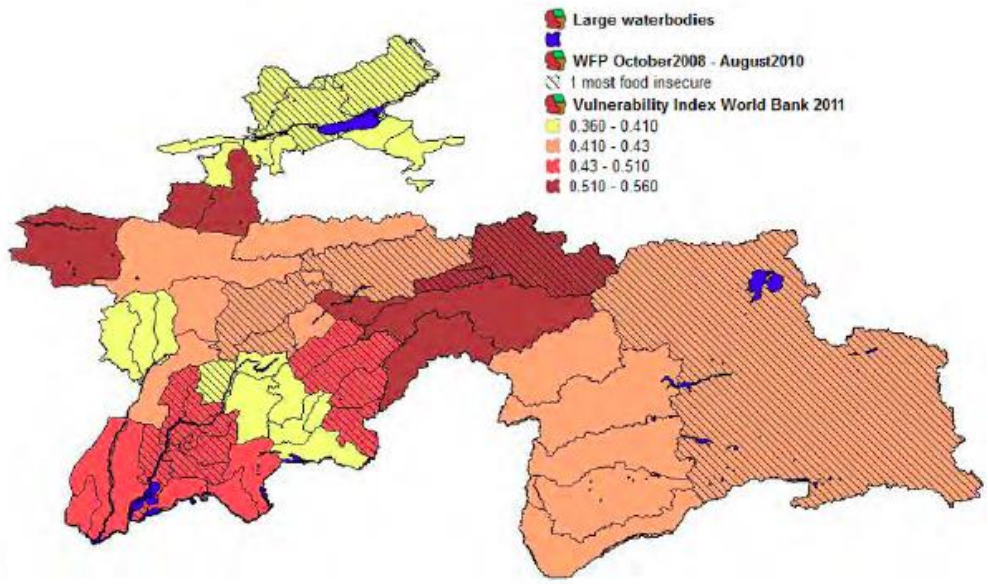


Figure 12. Household vulnerability to climate change and most food insecure districts

Sources: Heltberg and Bonch-Osmolovskiy 2011; WFP surveys between October 2008 and August 2010

Turkmenistan

Second National Communication of Turkmenistan to the UN FCCC (Turkmenistan 2010) mentions that according to the observed scenarios of accumulated annual precipitation and

moisture deficit, grassland productivity may decline to 10-15%. There was no vulnerability assessment conducted for crops or other parameters though.

Climate change impacts on agriculture of Central Asia

Based on the few projections made on the effects of climate change on agriculture in Central Asia region, the key impacts were identified and presented in this chapter.

In Kazakhstan, based on the projected impacts of climate change to 2100, a combination of rising temperatures, declining average rainfall, and regional deglaciation are projected to cause (Kazakhstan 2009):

- Growth of drought frequency and intensity in rain fed farmlands and pastures;
- Time shift in sheep pastures' availability (earlier in spring);
- Higher risk of land salinization in irrigated farmlands;
- Growth of land erosions for pastures and farmlands;
- Decrease in water availability, causing overstocking and erosion in the area of water sources;
- Increased mudflows as a result of forest cover decline, harming the most productive lands on the piedmont plains of Kazakhstan.

Potential negative impacts for agriculture from changing climate in Uzbekistan include (Uzbekistan 2008):

- Water deficiency leading to declining irrigation rates, water stress;
- Salinization increase;
- Increased duration, frequency and intensity of extreme weather events;
- Increased outbreaks of pests and diseases;

- Increased aridity, especially in dry season;
- Crop yield losses;
- Decline in rangeland productivity, deterioration of fodder base;
- Risk of heat stress for livestock.

According to IFAD Summary report on Climate Change Impact on Pastures and Livestock Systems in Kyrgyzstan (IFAD 2013) the country specific impacts of climate change will be:

- Increased floods and water logging in spring because of more intense precipitation in Fergana Valley and Chuy district. This will lead to negative effects for infrastructure and access to pastures;
- Livestock in Chuy Oblast, Talas and Fergana Valley will experience high temperature stress with frequent temperatures over 30C;
- Increased risk of mudslides in Fergana Range, eastern Issyk-Kul, Batken, Talas, etc. may affect the access to spring pastures;
- Intense snow melting due to increased temperature and precipitation will be very likely, causing damages to infrastructure, disrupting access to pastures and so on;
- Pastures might benefit from increased productivity due to a longer growing season and milder winters (Ashlev and Ershova 2012).

Key risks and negative impacts of climate change on agriculture in Tajikistan can be best summarized by the chart (Figure 13):

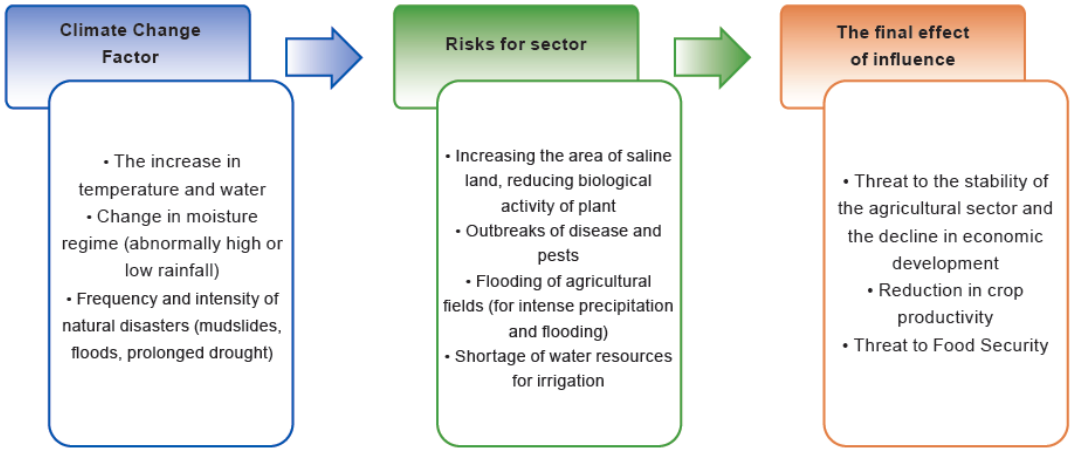


Figure 13. Risks and impacts of climate change on agriculture

Source: Oprunenco and Lafiti 2010

The key impacts of climate change on agriculture in Turkmenistan can be described as follows (Turkmenistan 2010, Bizikova *et al.* 2011):

- Changes in crop yields and species structure of forage due to decreased amount of rainfall;
- Increased water demand for irrigation by 30-40% because of higher temperatures; together with decreased water availability will likely lead to drop in crop yields;
- Heat stress leading to decreased sheep productivity;
- Drop in soil moisture in the 0-20 cm layer; land salinization.

Climate Smart agriculture

Defining the concept

The concept of climate-smart agriculture (CSA) was first presented at the Hague Conference on Agriculture, Food Security and Climate Change in 2010 by the Food and Agriculture Organisation of the United Nations (FAO) as an approach for achievement of sustainable development goals (SDGs). This is an approach that incorporates all 3 pillars of sustainable

development (environmental, social and economic) though complexly targeting food security and climate change issues. It includes:

- Sustainably increasing agricultural productivity and farmers' livelihoods;
- Adaptation and enhancing resilience to climate change;
- Cutting on green house gas emissions, where possible (*Figure 14*).

This approach also includes creation of such conditions (policy, technical, investment), which would enable sustainable agricultural development under climate change. Creating such conditions and making transformations necessary for CSA is possible only though analysis of local specificities. That's why CSA approach takes into account the environmental, social, and economic context where it is to be implemented.

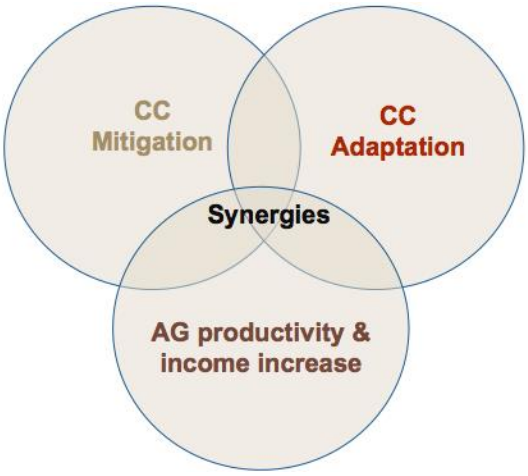


Figure 14. Climate smart agriculture approach

Source: FAO 2016

CSA is not a single agricultural practice. It is an approach that requires local-specific analysis to identify a set of suitable agricultural practices.

CSA combines practices that are not necessarily innovative but are used in the context of climate change, obscure to farmers. Also new is the way of addressing several issues at the same time, avoiding overlap or contradiction in regulations, policies and financing.

Scaling up and dissemination of CSA practices from small pilot projects to a larger scale requires development of special strategies, rising awareness, building linkages between sectors, creation of enabling environment and market.

The concept of climate smart agriculture has many common principles with the concepts of sustainable development and green economy. All three has objectives to preserve natural resources and enhance food security.

It is also closely related to the concept of sustainable intensification, which was also developed by FAO for crop production.

Agriculture is a necessary and important part of green economy, according to (FAO 2013). "Greening Economy with Agriculture" was proposed by FAO as the main message for Rio+20.

CSA is one of ways to make sustainable development tangible. It combines 3 dimensions of sustainable development (environmental, social and economic) for addressing climatic and food security concerns of today and future. For the Rio+20 outcome document the same principles are key, as it recognizes that resource efficiency is one of the most important parts for building agricultural resilience.

Apart from sharing the dimensions of sustainable development, the concepts of CSA and green economy both address global problems with long-term impacts by acting locally. CSA helps addressing climate change on global scale, while supporting adaptation to it on local scale. The same food security is to be addressed both locally and globally.

Sustainable intensification of crop production (SCPI) also has common objectives with CSA. SCPI could be expressed in two words: save and grow. It uses ecosystem approach of agricultural production increase through conservation and enhancement of natural resources and ecosystem services and through timely application of inputs to improved resource-efficient and resilient crop varieties. CSA concept has additional aspect of integrating future perspective – potential changes and the necessity to be prepared for them.

To sum up, CSA approach:

1. Addresses simultaneously interconnected issues of food security and climate change by choosing options, which make synergies and cut trade-offs;

2. Identifies options tailored to specific local social, economic, and environmental conditions where it is to be implemented;

3. Identifies different groups of existing and potential stakeholders and analyses interaction between sectors;

4. Identifies constraints to adoption and find the right solutions for overcoming these constraints (policies, incentives etc.);

5. Supports creation of enabling environment through development and harmonization of policies, institutions and investments;

6. Seeks to identify priorities and trade-offs needed;

7. Seeks to enhance livelihoods of agricultural producers (especially smallholders) through facilitation of knowledge, information and technology exchange and improving access to markets and financing;

8. Helps to adapt and become more resilient to shocks, especially climate-related;

9. Incorporates mitigation of climate effects as a potential secondary co-benefit;

10. Supports mobilisation of combination of financial resources, such as climate-related financing and agricultural investment finance.

Climate smart practices suggested for Central Asia

This chapter will show the results of the analysis of key national policies and studies conducted for the region, which was aimed to identify climate smart agricultural practices, suggested for implementation in the countries of Central Asia. Here are the key solutions, which were found out:

- Conducting selection and introduction of high-yielding varieties of crops resistant to diseases (Oprunenco and Lafiti 2010) and pests (Tajikistan 2003), drought-resistant (Tajikistan 2014; Uzbekistan 2008), heat-tolerant (Tajikistan 2003) and tolerant to salinity (Kyrgyzstan 2014), as well as genotypes that better tolerate the conditions of low-use of material and equipment; fast-growing (Tajikistan 2003), and crops consuming less irrigation water (Uzbekistan 2008; Baigarin et al. 2008); selective breeding of more climate stress-adapted sheep breeds (Kazakhstan 2013; Sutton et al. 2013);
- Regulate the load on cattle pastures through different seasonal grazing (Kazakhstan 2009), wide use of summer mountain pastures for sheep farming, (Baigarin et al. 2008; Kazakhstan 2009), put into use remote pastures with partly restored plants; (Kazakhstan 2009), reestablishment of the transhumance system (Kazakhstan 2013), development of the grazing and stabling system on an industrial basis (Kazakhstan 2013);
- Reduction of wind erosion impact, conducting phytomeliorative activities with application of trees planting (Uzbekistan 2008), creating strips of pasture fodder trees and

shrubs (Kyrgyzstan 2014; Aganov et al. 2015), establishing forest protection zones (Tajikistan 2008), promotion of silvo-pastoral systems (IFAD 2013), establishing of agroforestry plots on degraded cropland and grazing land (Wolfgramm et al. 2011), formatting of pasture protection belts consisting of fodder dendro-shrubby plants: kandym (Callidonum setosum), saxaul (Halaxsilon), chogon (Salsola sudaphyla), saltwort (Salsola richteri), etc. (Turkmenistan 2010);

- Optimization of livestock farming locations, given the current and future climate (Baigarin et al. 2008), improvement of allocation pattern of agricultural crops (Uzbekistan 2008), optimisation of agro-technical activities timing according to the weather (Kazakhstan 2013; Baigarin et al. 2008; Kyrgyzstan 2009a), optimization of agronomic inputs, including fertilizer application (Sutton et al. 2013);
- Diversification of crop production with high yielding crops (Kazakhstan 2009), diversification towards crops that use less water (Barbone et al. 2010), inclusion of legumes in crop rotation system (Oprunenco and Lafiti 2010), introduction of the cotton-alfalfa crop rotation (Uzbekistan 2008), elaboration of effective schedules of crops rotation and cotton sewing zones (Tajikistan 2003), extending the area of crop rotation up to 25% of the total irrigated area (Oprunenco and Lafiti 2010), gardening (Wolfgramm et al. 2011);
- Development of organic farming (Tajikistan 2014), introduction of organic fertilizing (Baigarin et al. 2008), protection of crops from pests and diseases, using biological methods (Tajikistan 2014);
- Introduction of no-till technology of soil treatment (Kazakhstan 2013), restriction in growing one year agriculture crops on slopes steeper than 12 degrees; use the eroded land

under perennial grasses (Oprunenco and Lafiti 2010), land planning using laser technology (Aganov et al. 2015)

- Application of surface furrow irrigation, night irrigation, sprinkling irrigation, subsoil water irrigation (Uzbekistan 2008), drip irrigation, irrigation with plastic pipes (Kazakhstan 2013), improving efficiency of irrigation channels by lining of channels' bed, especially in the areas of high water filtration (Tajikistan 2014), extensive use of irrigation in moisture charging water application in early spring season, the use of techniques of snow holding, conducting the melt snow watering (Oprunenco and Lafiti 2010).

Constraints and mechanisms for transition to CSA in Central Asia

Constrains for adoption of CSA practices in Central Asia

In order to understand which policies and other mechanisms might enhance the adoption of climate smart practices, I will look at all possible constraints to adoption in Central Asia region, which where described in the literature.

Antle and Diagana 2003 claim that there are a variety of factors that might affect farmers' land use and management decisions. In this process it is important to recognize not only the role of farmers, who make choice whether to adopt or reject the practice, but also of other stakeholders. Practitioners, local leaders and other decision makers can also influence individual farmer's decisions (Place and Dewees 1999).

Tashmanov *et al.* 2000 is convinced that republics of Central Asia don't have "unified formula" for transition to sustainable development because of the geographic, economic, demographic, cultural, and other differences. But nevertheless, they have a lot of common constraints for

scaling-out of climate smart practices. They, as well as specific challenges for each country are discussed below.

Political constraints

In much of Central Asia political factors are a primary constraint to sustainable agriculture (Bobojonov *et al.* 2013).

State order and procurement

One of the main political constraints to crop diversification, sustainable crop rotations and other climate smart practices is the state order, in particular in Uzbekistan and Turkmenistan, which determines the area of farmland that should be cultivated with cotton and other strategic crops, and also forces farmers to produce a prescribed amount of each crop from a given cropland (Khasanov and Djanibekov 2015). According to Pomfret 2007a, in Tajikistan many farms are also subject to state control over cropping and harvesting decisions.

Almost all the amount of strategic crops in Uzbekistan is state procured, and export is dominated by monopsonic state companies (Spoor 2007/10). Hirsch 2008 describes that farmers owning more than than 10 ha of land are obliged to cultivate strategically important crops such as cotton and wheat, the yields of which are delivered to state-owned ginneries. Because the state rather than the land user decides on crop choice on the largest parts of the land, increasing the area of alternative crops above a certain threshold is not possible (Bobojonov *et al.* 2013). For example, as Wall 2008 mentions, some practices, such as inter-row planting of wheat or melons in the cotton, are officially banned.

In theory, farmers in Uzbekistan have to allocate around 70% of their arable land to cotton and winter wheat production (Bobojonov *et al.* 2012). On practice, only 10 % of farm land is

available for other cultures (Wall 2008). Therefore, state order for strategic crops is the main reason for reluctance and resistance of agricultural producers to crop rotations (Bobojonov *et al.* 2008). This is also because the state plan system also prescribes exact farming methods, including depth of ploughing, land levelling, harvesting times, and regimes of fertiliser application (Wall 2008).

According to Kienzler *et al.* 2012, conservation agriculture practices are more difficult to promote, because practices that might lead to yield reductions (even initial) of the strategic crops are unlikely to find support with the government in Central Asia.

Introduction of water service fees (WSF) with the aim to decrease crop water demand might also not bring the expected results, unless farmers are given more flexibility in their production decisions. (Djanibekov *et al.* 2012)

Other state policies

Schoeller-Schletter 2008 mentions that the land reform in Uzbekistan has strengthened the role of the hokims (district and regional governors), who are pressured by the central government in implementing policies of the central state. This strong intervention of local governments into farm management has led first, to significant losses in productivity (IAMO 2008) and also constantly constrains decision making autonomy of the farmers both on output and input side (Wehrheim and Martius 2008). According to Spoor 2007/10, political interference from hokims makes the business climate in Uzbekistan more difficult.

Government of Uzbekistan is strongly involved in agricultural decision-making at all levels (Hornidge *et al.* 2011).

The control of agricultural inputs is the most prominent for fertiliser, seeds, water and mechanical traction, for which farmers rely on the state monopolies and have only a limited selection of private providers. Farmers receive and are ready to get inputs when they are available, because often monopolistic suppliers deliver them at times convenient to the supplier, with little regard for demand. This causes delays in inputs application and, in turn, crop reductions. But because of the state monopoly, farmers can't choose providers with better quality of service (Wall 2008).

Bekchanov *et al.* 2010 states that because of non-transparency and a high degree of government intervention in agriculture, livestock sector doesn't seem beneficial for farmers. Interference of authorities into the elections of the heads of agricultural service providers makes them dependent on central decisions and undermine their reliability in the eyes of clients (Vlek *et al.* 2012).

According to Hornidge *et al.* 2011, authoritarian political system of Uzbekistan heavily dominates the diffusion of innovations by the "linear model of technology supply push" in society, which is used to uptaking rather than critically questioning practices provided by the state. Pomfret 2007a also claims that since the collapse of Soviet Union, there is little evidence of shifting from "top-down" technology transfer towards more participatory approaches in Central Asia.

Some Central Asian countries like Uzbekistan have tillage regulations that constrain use of conservation agriculture practices, limiting the possibility for farmers to leave crop residues on the field (FAO 2013a).

According to Juraev *et al.* 2000, some outdated instructions and regulations cause investment in nonproductive activities, ineffective use of credit and improper use of financial resources. Moreover, restrictions on access to foreign exchange accounts and currency still exist in Uzbekistan, although officially it was abolished in 2003 (Pomfret 2007a).

Market restrictions

According to Bobojonov and Aw-Hassan 2013, restrictions of trade by state policies and low exchange of agricultural commodities between the countries are the main challenges for small farmers in Central Asia.

In Kazakhstan and Kyrgyzstan after liberalisation of the supply chain producers are free to choose input and output channels, services and processing (Spoor 2007/10).

In Tajikistan, some changes happened after 'futures holders' export companies have emerged, but there is still some degree of official and unofficial government intervention at the regional level (Spoor 2007/10).

Pastor and Van Rooden 2000 argue that the main constraints for development of agriculture in Turkmenistan are trade barriers, such as quantitative import and export restrictions from State Commodity Exchange (Pastor and Van Rooden 2000).

Legal constraints

Bekchanov *et al.* 2010 mentions improved legal framework as a precondition to implement such practices as including more profitable fruit and vegetable production in the cropping plans. But this is constrained by insecure property rights for land and other resources, undefined responsibilities of WUAs, which undermines development of innovations (Bekchanov *et al.* 2010).

Moreover, as Wall 2008 states, apart from formal legal institutions, there exist informal institutions – "the rules of the game" – which have more influence on practice.

Jansky and Pachova 2006 mention such problem as poor linkage of rural land management activities for the High Pamir and Alai Mountains to the national environmental legislation, that's why they are not able to operate effectively outside regulatory control and direction.

According to Jansky and Pachova 2006, national-based legislative and regulatory framework in countries of Central Asia gives little flexibility to allow for local modifications to meet area specific resource needs and conditions, and hinders effective promotion of sustainable land management practices within the region in general.

Land tenure

According to Place and Dewees 1999, willingness to invest in resource decreases in the absence or uncertainty of long-term or exclusive rights to benefits from this resource. So when the farmers don't own their land, or their rights are insecure, or the tenancy contracts are not long term, they will have little incentive to make long-term natural resource investments (Place and Dewees 1999), especially to implement sustainable land use practices (Wall 2008). For instance, in the absence of private land tenure, farmers in Uzbekistan and Turkmenistan are reluctant to adopt conservation agriculture practices despite such benefits as increase in soil organic matter (FAO 2013a). And Wall 2008, describing his research, noticed, that in the majority of cases farmers, who's land tenure was long and more or less secure, showed more willingness to implement sustainable land use practices, and many were using more natural fertilisers like cow manure.

When land tenure is for the short term or not secure, farmers tend to prefer getting quick profit gains from land over sustainability (Wall 2008). On other hand, when property rights to land are secure and guaranteed, farmers have an incentive to manage well their land in order to keep it a valuable capital (Antle and Diagana 2003).

As Schoeller-Schletter 2008 brilliantly wrote about farmers in Uzbekistan: “If the individual cannot be sure that his rights are being protected, he will be reluctant to take individual responsibility, or make personal investment. It is not astonishing therefore, that an Uzbek farmer, to whom "privatization" has entailed above all the "privatization of risk", who does not have the certainty that he will work the same fields again in the future; who does not have the freedom to choose the crops and the buyer of his products; and who does not have a realistic chance to seek and find justice in court against administrative acts, will not invest in the soil quality of his fields, even if they are allotted to him for his own use.”

In Central Asia land can be taken away from farmer at any time by decision of local (hokim) or other senior administration for improper use. Land law of Uzbekistan (2002) specifies that farms must "provide for supply of agricultural production on government requests in compliance with signed agreements of contracting within limits of envisaged volumes" and that "violation of land legislation, including cases of utilisation of land area for the purposes other than farming, including sowing agricultural crops, not specified in the contracting agreement" will lead to the liquidation (Wall 2008).

In Turkmenistan, in spite of existing principle of private ownership in the Constitution (1992), the land could not be transferred and can be reallocated if not used properly (Pomfret 2007a).

Not only the farmers’ land plots, but pastures are legally the property of the state, which encourages short-term resource exploitation rather than long-term conservation (Jansky and Pachova 2006), thus limiting possibility of adoption of sustainable pasture use practices.

Economical constraints

“In much of Central Asia, economic factors are a primary constraint to sustainable agriculture” (Bobojonov *et al.* 2013).

Procurement capacity

A real barrier to implementation of any sustainable technologies, according to Wall 2008, exists for poor farmers in Central Asia, because they cannot risk to get reduced crop yield, which may geopardise their ability to continue farming. Meaning the majority of farmers also cannot afford short-term reductions in profitability for achieving long-term economic benefits and sustainability.

According to Bekchanov *et al.* 2010, costs of implementation of water-wise practices affect the willingness of farmers to adopt them, because the farms of the region are undercapitalized and farmers are not able to take the risk of high initial investments, required for example for technologies such as drip irrigation (Bekchanov *et al.* 2010; Hellin and Schrader 2003).

Vlek *et al.* 2012 mentions, that farmers in Uzbekistan, when producing alternative crops, are exposed to increased risks, stemming from need in up-front investments in new crops, including machinery, fertilizers and seeds.

Perverse subsidies/tariffs/taxes and other disincentives

Antle and Diagana 2003 argue that subsidization of agriculture in Central Asia causes low agricultural commodity prices, which decrease willingness to invest in sustainable agricultural practices. Import-substitution trade policies and use of different tariff and nontariff barriers cause high domestic input prices.

Incentives to increase the area sown by wheat in Uzbekistan caused substantial decline in acreage under fodder crops, and further undermine introduction of sustainable crop rotation. Similar effects are seen in other Central Asian republics, where they are more market-driven (Pomfret 2007a).

According to Wall 2008, in Uzbekistan there is a range of disincentives for the innovation of agricultural methods. He mentions, that seeds for strategic crops are provided free of charge or at very cheap prices by the Government. Climate smart practices as improved sowing and tillage methods could substantially reduce seed inputs, but there is no real incentive to do so.

Inadequate water pricing

Another problem connected to the lack of economic incentives, is the inadequate water pricing (too low), which does not stimulate farmers for water-saving practices (Bekchanov *et al.* 2010).

In Central Asia a water service fee (WSF) is imposed mostly at a fixed rate for all farms, based on the area, not on the type of crops grown and their water-demand (Djanibekov *et al.* 2012). This disencourages farmers to cultivate water-non-intensive crops.

Institutional constraints

Markets

Undeveloped input channels

One of the biggest challenges for farmers has been the absence of well-functioning input markets, especially for machinery, fertilizers and pesticides, and extension services (Spoor 2007/10). According to Guadagni *et al.* 2005, inputs are often delivered with delay and cannot be used efficiently.

According to Bobojonov *et al.* 2013, this constrains development of crop diversification, for example, by lack of alternative crops seeds. In Khorezm region the absence of high quality potato seeds was the most limiting factor for enhancing potato production.

In almost entire Central Asia region, crop stubbles, essential for conservation agriculture, are often burned because there is a lack of suitable, powerful tractors for plowing (FAO 2013a).

Also, conservation agriculture recommendations for crops cannot be fully used by farmers because seed availability is a constraining issue (Kienzler *et al.* 2012).

Bekchanov *et al.* 2010 state that factors constraining adoption of innovative technologies and practices by farmers in Uzbekistan are poor farmer-to-market linkages and high costs of transportation to the urban markets. This limits the chances for obtaining adequate prices. Low availability of technology imports impedes implementation (Bekchanov *et al.* 2010).

Undeveloped output channels

Baydildina *et al.* 2000 consider the development of market infrastructure, road construction and transportation very important for creating favorable conditions for adoption of sustainable practices.

In Central Asia the market infrastructure for selling a diversity of crops is poorly developed (Bobojonov *et al.* 2013). Marketing channels are not commercially sufficient and the only channels available to small farmers are local markets (bazaars) (Tashmanov *et al.* 2000), whereas transportation costs to urban markets are too high (Bekchanov *et al.* 2010). According to Bobojonov *et al.* 2013, in the absence of efficient linkages to markets in the region or at feasible distances from it, alternative crops at present are mainly cultivated for household consumption but not for income generation.

Banking and financial constraints

Credit and loans

According to Bobojonov *et al.* 2013, another constraining factor is lack of savings and credit institutions. He argues that introduction of sustainable crop diversification requires investments, in particular in specific agricultural implements. Banks in Uzbekistan do offer credits to farmers

with good rates, but at condition that they will be used for strategic crops (Bobojonov *et al.* 2013).

Spoor 2007/10 claims that rural financial institutions in countries of Central Asia are poorly developed. For the majority of rural population formal banking services are almost inaccessible, because banks are mostly concentrated in capitals, on substantial distances and with poor transport infrastructure.

In Tajikistan only two banks operate in rural areas, in Kyrgyzstan - just three; in Kazakhstan, the engagement of banks in rural areas is minimal, whereas Uzbekistan has seven banks active in rural areas (because of state credit support to cotton and wheat)(Spoor 2007/10).

According to Tashmanov *et al.* 2000, there where attempts to reform existing agricultural finance system in Uzbekistan. It was planned to create Tadbirkorbank to provide credits and loans to small farms and to privatize Agroprombank and divide it into three separate banks with different crop specialization. Nevertheless, these objectives were not achieved.

Restricted accounts

In Uzbekistan, in order to control tax payment, enterprises, including farms, are allowed to open only one bank account (Juraev *et al.* 2000). For some agricultural commodities like cotton, payment can be done only directly to settlement bank accounts, withdrawals from which are strictly controlled (Hirsch 2008; Vlek *et al.* 2012). From these accounts farmers can transfer payments for fertiliser or equipment, and they can borrow money from this account to pay for other inputs. Farmers don't actually see their physical money (Wall 2008).

The payments for electricity or fuel for irrigation are also transferred from the bank accounts of farmers without previously notifying them (Hirsch 2008). Taxes are also deducted automatically

from these accounts. The information about accounts statement and all transactions is always available to local officials for control of farmers' activities (Wall 2008).

For farmers it is almost impossible to get cash from their bank accounts since banks are refusing or not able provide cash payments. Non-state providers of machinery or other inputs are not allowed to receive deposits to their settlement account, so they must be paid in cash. That's why the majority of farmers, especially those who borrow money from their account to pay for inputs, are not able to use service of private input providers (Wall 2008). This constrains adoption of new sustainable practices if they are not being implemented by state.

Processing and storage

A lack of processing and storage options is another major constraint (Bobojonov *et al.* 2013).

According to Bobojonov *et al.* 2013, facilities constructed in the USSR, have deteriorated. He mentions that this obstructs development of production of fruits and vegetables, because otherwise surplus could be exported (Bobojonov *et al.* 2012). Due to the lack of processing capacities in the region, alternative crops can be grown only for household consumption but not for income generation (Bobojonov *et al.* 2012; Bobojonov *et al.* 2013). To revive the vegetable production in Central Asia, Djanibekov 2008a suggests regional policy makers to promote on-farm processing technologies. An ease of these constraints should help spreading of crop diversification in Uzbekistan (Bobojonov *et al.* 2013).

Djanibekov 2008a also states that further development of the livestock sector in the region depends on improvement of processing industry of dairy and meat products.

Research

Following the breakdown of Soviet Union there has happened a substantial deterioration in agricultural science sector, and development of innovations was under-funded in countries of Central Asia. Due to this extension services has much deteriorated too, but if they are not efficiently provided, crop diversification will remain constrained (Bobojonov *et al.* 2013), as well as other climate smart practices.

A lack of ecological monitoring is another problem that limits introduction of crop diversification (Bobojonov *et al.* 2013).

Wall 2008 argues lack of academic freedom exists at all levels in Uzbek republic. This poses a serious constraint to research and agricultural technology change. The issue was perfectly described by Wall 2008 in Uzbekistan. He states that research institutes face considerable political interference. Cotton and wheat research institutes are narrowly specialized on their particular area and don't perform any research on alternative crops. Those researches, who dare to question cotton and wheat policy or who propose paradigm shifts in agriculture, don't get promotion.

Universities have almost no ability to pursue independent research. Moreover, any research or activity that may pose threat to strategic crops is being closed down or constrained. For instance, an international project promoting potato growing in the Khorezm region undergone severe sanctions with the purpose to make their extension services ineffective (Wall 2008).

Education and knowledge

Place and Dewees 1999 argue that lack of knowledge of environmental problem like climate change and its impact on agriculture can be a serious constraint on different scales of adoption of new technologies.

Antle and Diagana 2003 state that farmers of Central Asia region due to lack of education and knowledge on how their agricultural practices decrease productivity, may use these practices and degrade soil resources unintentionally.

Bekchanov *et al.* 2010 discusses that, although there exists a huge variety of practices of effective water use, farmers don't widely adopt these practices because they lack necessary knowledge about them.

As a reason why conservation agriculture and other sustainable practices are not yet commonly used by farmers in Central Asia, Kienzler *et al.* 2012 sees lack of clarity about existing types of technologies and practices and their role in enhancing food security and adaptation to climate change. Another reason for this, according to Bekchanov *et al.* 2010, is the restricted access to information.

The issue is exacerbated by ongoing 'knowledge loss' and a 'growth of ignorance' (Hornidge *et al.* 2011).

Social constraints

Religious constraints

Attitude to water

Bekchanov *et al.* 2010 claims that one of the constraints to implementing water efficient measures in the region of Central Asia is unwillingness of the population to perceive water as a tradable good.

Hirsch 2008 explains this phenomenon by "the legacy of the Soviet system" which provided the majority of inputs and especially water free of charge, and also by Islamic believes that water is a common good.

Attitude to credit

Bachmann 2011 in the study for organic cotton in Kyrgyzstan analyses the results of interviews with farmers. According to him, many of the interviewees claimed they are uninterested in taking credits – although they had access to it—due to religious reasons. Muslim religion considers any kind of borrowing money/credit/loan as a sin.

Dietary habits

As Kienzler *et al.* 2012 states, regional dietary choices and preferences in Central Asia constrain promotion of diverse legumes and fodder crops, new to the region.

Preconceptions

According to Kienzler *et al.* 2012, one of the factors, which explain why conservation agriculture and other sustainable agricultural practices are not widely used by farmers in Central Asia, are doubts about the technical performance of these practices, which still dominate the mindsets of

the authorities. Wall 2008 considers farmers' and decision makers' preconceptions to be caused by bad quality of agricultural education and restricted farm management autonomy.

Farmers in Central Asia are strongly convinced in the necessity of tillage practices since the time, when mechanisation and extensive ploughing were perceived as best practices of Soviet agriculture, and are largely suspicious of no-tillage. The idea of substitution of ploughing with permanent or semi-permanent bed planting is considered ridiculous. The fact that with sustainable irrigation methods less water could be used at the same time with getting the same yield, is deemed impossible by the vast number of farmers (Wall 2008).

Existing cases of CSA practices used in CA and mechanisms for their promotion

Conservation agriculture in Northern Kazakhstan

In 2011, conservation tillage and no-till practices were implemented on 11.7 M ha in Northern Kazakhstan. It makes 70% of the whole area under wheat in Kazakhstan. As a result, the yield of grain obtained was very high; it reached 20 Mt or 1.7 t/ha. Even introduction of some conservation agriculture practices gave such good result. The area under full conservation agriculture in Kazakhstan (in the north) amounts to only 1.6 M ha (FAO 2013a).

The region has good conditions and potential for upscaling of conservation agriculture (Thomas 2008). The territory is rainfed, relatively flat, prone to erosions (Kienzler *et al.* 2012). Historically the process of involving resource-conserving practices in this area began in 1960s in attempt to prevent wind and water erosion processes. (Kienzler *et al.* 2012) Since independence, farmers started to diversify their crops and to apply sustainable land management (Thomas 2008).

According to Kienzler *et al.* 2012, the rapid dissemination of CA practices was partly caused by the high amount of large agricultural joint-stock companies, owing vast land areas, who became the main adopters.

But the most important effect had the state policy of Kazakh government, which aimed to help the dissemination of conservation agriculture practices:

Input supply. Seeders were made available by providing import of proper equipment in the area, and also attempts are made to develop local manufacturing of the suitable machinery (Kienzler *et al.* 2012)

Subsidies. In 2011, the Government of Kazakhstan adopted a Resolution, according to which was developed a flexible strategy of subsidizing farmers. Subsidies for using conservation agriculture practices are 3-4 times higher than for conventional practices. For instance, subsidies for adoption of no-till technics were around 6$/ha. This had very positive effect on uptake of conservation agriculture by farmers.

Research. In agricultural research, the priority area is resource-saving technologies. In the last years researchers are often conducting workshops, Farmers' Days and trainings (FAO 2013a).

This case is a good example showing that transition to sustainable agriculture is possible if policy and institutional support mechanisms are used (FAO 2013a).

Organic cotton in Southern Kyrgyzstan

In 2004, the BioCotton Project was organised in southern Kyrgyzstan, province Jalal-Abad by Swiss NGO Helvetas. The project of organic cotton growing first involved only 58 farmers. But during next years it has substantially spread up and by 2009, already 765 farmers were cultivating 1200 ha of land, from which 312 ha was under organic cotton. In 2007, the BioFarmer Cooperative and the BioService Foundation were established as supporting institutions. Farmers sell their organic cotton at fair trade, which means that they receive a guaranteed minimum price, which must cover all producer's cost, including production, living expenses, registration, auditing and certification. Plus they get both organic and fair-trade premiums.

Range of mechanisms, motivating farmers to convert to organic cotton growing includes (Bachmann 2011):

Access to credit. Organic farmers are provided with easily accessible credit on favorable terms, which is secured by social collateral. For this purpose, the BioFarmer Cooperative has an agreement with Agrokreditplus, which is a microfinance institution. It explains the higher number of livestock, owned by organic farmers in comparison to conventional cotton-growers – they don't have to sell out their livestock on the market, when they need money.

Marketing support. BioFarmer Cooperative also arranges collection, transportation and marketing of organic cotton. Organic farmers have guaranteed buyer for their harvest at a fixed in advance premium price. For example, in 2008 it was a German company. Opposite to this, conventional cotton farmers have to find the buyer themselves, and they are also dependent on world cotton price fluctuations.

Extension services. Organic farmers are provided with trainings and extension services by the BioService Foundation. In contrast to conventional farmers who don't receive any constant extension from the state due to its absence or unawareness of farmers about their existence.

Provision of seeds. Organic farmers receive seeds as an interest-free loan, meaning they only pay for them after collecting the harvest (Bachmann 2011).

Apart from this, organic cotton farmers also received by-products: cotton oil and seed cake as a bonus. Also in-conversion cotton farmers, who are not yet certified and eligible to receive premium prices, receive help in the form of fair trade minimum price with additional small premium (Bachmann 2011).

Potential mechanisms for transition to CSA in Central Asia

According to Babu and Pinstrup-Andersen 2000, the countries of Central Asia are facing similar constraints and thus, policy research results generated in one country could be applied with appropriate modifications to other countries in the region.

Accelerating diffusion of sustainable agricultural technologies and practices, especially when it faces multiple constraints, requires use of special mechanisms with the aim to help this diffusion (Pomfret 2002).

These mechanisms sometimes are called incentives. Incentive is an any kind of motivation from an external agency (government, NGO or other), which allows or encourages the local population to adopt new techniques and practices of sustainable agricultural management (Hellin and Schrader 2003). Most authors divide them into direct and indirect incentives (Figure 15).

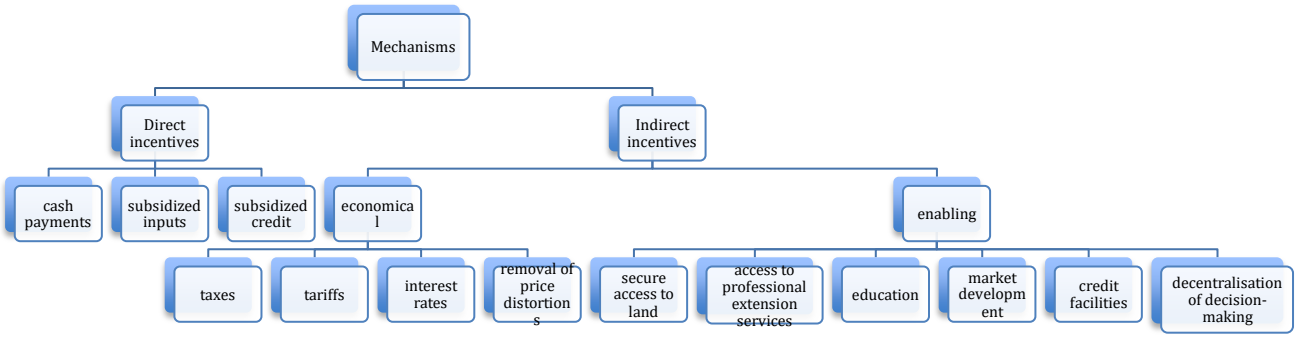


Figure 15. Typology of incentives

Hellin and Schrader 2003 argue that incentives at the beginning of introduction of sustainable agricultural practices are critical because farmers might be not able to afford up-front costs of technologies, and because the benefits of improved yields can be delayed.

Theoretically, once farmers experienced the benefits of sustainable practices, direct incentives may be excluded (Hellin and Schrader 2003).

Hellin and Schrader 2003 claim that without direct incentives farmer adoption of or spontaneous diffusion of practices don't happen. But once the direct incentives are withdrawn, farmers don't continue using sustainable practices, and existing structures are seldom maintained. That's why the provision of indirect incentives, which are often dependent on policy decisions made at central government level, is necessary (Hellin and Schrader 2003).

Direct incentives

According to Hellin and Schrader 2003, farmers' responses to sustainable agricultural practices to a large extent depend on the type of direct incentives used. While cash payments are good stimulators for establishment of technologies requiring heavy physical work, distribution of free seeds or seedlings works well for encouraging farmers to implement measures as tree belts and contour cropping.

Cash payments

Thomas 2008 suggests introducing payments for environmental services (PES) in relation to climate change. The rangeland, which are substantially overgrazed and degraded in Central Asia would benefit from private sustainable management. In turn, those land users who conserve and manage these rangelands should receive incentives as a payment for the environmental services that managed rangelands provide.

Another financial incentive for adoption of climate smart practices could be governmental programs or private contracts to sequester soil C. Antle and Diagana 2003 mention that it could be payment to farmers for each unit of area on which they adopt sustainable agricultural practices, or per ton of carbon sequestered.

FAO 2013a suggests several actions for policymakers in Central Asia countries decided on Regional Workshop on 'Save and Grow': establishment of incentive mechanisms such as payments to eco-effective land users and an introduction of penalties for users of degrading agricultural practices (FAO 2013a).

Subsidized inputs

According to Bekchanov *et al.* 2010, new technologies require various subsidy schemes in order to be adopted by farmers, because they will help to decrease the costs of the equipment and its rental.

Bobojonov *et al.* 2010, discussing water-saving technologies, also mentions the importance of subsidies from government for technology adoption, which increase farmers' capital. He gives an example from Morocco, where farms get filtered water under pressure and also are provided with 60% subsidy from the state to cover the investment in onfarm drip irrigation (Bobojonov *et al.* 2010).

Indirect incentives

Hellin and Schrader 2003 claim that among the most effective incentives to improvement of land management is the creation of an enabling environment, including secure property rights on land and other resources, access to inputs and strong market channels, developed education and research systems, extension services and so on. Provision of these indirect incentives depends on policy and macroeconomics efforts from central government.

Economical

Taxes and tariffs

Supportive tax and tariff policies are important for facilitating commercial development of input supplies for conservation agriculture (FAO 2013a).

Bobojonov and Aw-Hassan 2013 describe the importance of tariffs and export tax policies for increasing the level of crop diversification; Place and Dewees 1999 discusses effectiveness of eliminating the withholding of VAT on important export goods; and Guadagni *et al.* 2005 suggest shift to a system of taxes based on actual revenues, because it would ease the burden on farmers.

Removal of price distortions

Place and Dewees 1999 argues that price distortions lead to low prices of agricultural commodities, thus decreasing the attractiveness of agriculture in general, which for sure influences the willingness to adopt sustainable agricultural practices. They discuss the importance of elimination of subsidies and other price distortions (such as uniform pricing of inputs or outputs throughout the country) that inefficiently reduce the cost of non-conserving practices such as mineral fertilizers and pesticides.

The example from East Asia shows that where mineral fertilizers are commonly subsidised farmers less likely adopt improved fallows because it is not deemed to be a profitable option for nitrogen supply (Place and Dewees 1999).

Trading schemes

Khasanov and Djanibekov 2015 suggest substitution of area-based production targets for cotton in Uzbekistan with quantity-based cotton targets. They argue that in this case farmers will be more flexible to decide which alternative crops and in which amount to grow, because they

would still be able to fulfill the cotton target by increasing yield on less area (Khasanov and Djanibekov 2015).

A 'market-based' instrument could be introduced in the cotton procurement policy – cotton target trading, namely possibility for farmers to contract other farmers at a negotiated price to buy part of their harvest, can be another incentive to improve cotton yield and to increase the degree of crop diversification and sustainable water use. The cotton targets trade could also allow farmers to take advantage of the quality of their land and proximity to irrigation channel. Opposite to current situation, it would bring more direct economic benefits both for those producing cotton and for those that may reduce area under cotton in favor of high value crops (Khasanov and Djanibekov 2015).

According to FAO 2013a, carbon offset trading could be another useful government-supported scheme to promote dissemination of conservation agriculture practices in Central Asia. Such scheme is successfully operating in Alberta, Canada. Examples of other schemes are water-related services in the Parani basin III in Brazil, or erosion control in olive groves in Andalucia, Spain.

Water pricing

According to IAMO 2008, introduction of water pricing for agricultural producers would shift production towards lower levels of water consumption and adoption of water saving irrigation technologies.

Because it would act as a perfect incentive to economize water, of course if the charged value is sufficiently high. Also it will lead to shifts in cropping patterns with substantial increase in water efficient crops (Djanibekov *et al.* 2012; Djanibekov 2008b).

Moreover, differences in the charges values among districts will cause reallocation of water between upstream and downstream areas. The variations of water charges value among agricultural producers within one district will support the principle of equitable water allocation among producers with differing production scales and will ease the burden on small-scale producers (Djanibekov 2008b).

The analysis presented in (IAMO 2008) suggests that the introduction of water charging as a single policy might negatively affect incomes of farmers, increasing production costs, which in turn will lead to decrease in regional welfare and production levels. Thus, WSFs could only be introduced gradually to allow agricultural producers to adjust (Djanibekov *et al.* 2012). Also, if the collected water fees are invested into restoration and improvement of irrigation and drainage systems, it will increase regional water productivity (Muller 2008b).

The reduced crop water demand and funds generated for O&M activities make this approach very important for adapting to and mitigating the negative effects of climate change (Djanibekov *et al.* 2012).

Enabling environment

Introducing sustainable land use or water-saving practices requires enabling policy environment and institutions, which will help to implement these policies (Djanibekov 2008b). Enabling agricultural policies are critical for alleviating constraints to adoption of conservation agriculture practices by farmers (Kienzler *et al.* 2012).

Land tenure

National policy should be developed in countries of Central Asia to ensure sustainable management of rangelands. While developing it, land tenure has to be addressed. Like in some

developed countries (United States, New Zealand) rangelands could be leased longterm under condition that a tenant will perform sustainable rangeland management and soil conservation practices (Suleimenov and Oram 2000). Tenure rights of the community to land and trees, both off-farm and on-farm, should be provided and secured (Place and Dewees 1999).

It is critically important to provide farmers with secure private ownership rights for land or at least to ensure long-term lease rights in order to stimulate investment in improving land quality and adoption of climate smart agriculture practices.

Research and extension services

Bobojonov *et al.* 2013 state that developing agricultural research capacities and strengthening the links between research, extension and farmers can facilitate diffusion of new sustainable technologies.

Hellin and Schrader 2003 argue that sometimes water-saving agricultural technologies provided to farmers, turn out to be inappropriate. That's why it is very important to enable farmers to express their opinions through participation in research and extension.

FAO 2013a also mentions that research should generate new knowledge in order to formulate locally suitable practices, depicting the diversity of ecological and socio-economic contexts. And then, whatever technological combinations are selected, R&D activities must help to ensure that the system of husbandry of crops, land and livestock function well on individual landscape units, farms and farming communities (FAO 2013a).

Extension should enable such activities as study-visits to demonstration areas of conservation agriculture and participatory learning for farmers, training on conservation agriculture principles

and application, research with farmers as partners and other opportunities for farmers to meet each other and discuss conservation agriculture matters (FAO 2013a).

Abdullaev *et al.* 2007 mention the importance of the agricultural extensions agencies in promoting of laser land leveling technology in the irrigated areas of Tajikistan. And Place and Dewees 1999 argue that there is a necessity to to train farmers on proper techniques of establishing seed orchards, selecting high-quality seeds, of nursery construction and operations, and seed collection.

Education

Adoption and dissemination of conservation agriculture practices need enhanced information and knowledge dissemination among farmers and policymakers about the principles and benefits of conservation agriculture (FAO 2013a).

Researchers and advisory staff need to be updated with ways of conservation agriculture principles application in different local contexts, their environmental and socioeconomic effects. There is a need to include conservation agriculture principles and benefits into the curricula of universities, colleges and schools (FAO 2013a).

Farmers need to understand and absorb new concepts to change their the mind-set. Thus, educating farmers is necessary for successful adoption and uptake of conservation agriculture practices. Policymakers in Central Asia countries should institutionalize the new way of farming as officially-endorsed policy in public sector education and advisory services (FAO 2013a).

Championship and collective action

It is recognised nowadays that during introduction of new practices it is very important to identify innovator farmers and to build on their experience. For instance, a farmer in Kazakhstan

who converted 28 thousand ha to conservation agriculture with no summer fallow served as an example for ICARDA (Thomas 2008).

Co-management and collective action are playing an important role in sustainable management of rangelands and in organizing payments for environmental services (Thomas 2008).

According to FAO 2013a, farmers-local champions in conservation agriculture are absolutely necessary for wide dissemination of practices, because they encourage others with their own success and example. When it comes to new technologies and practices, farmers believe more their peers than strangers-advisors. Supporting farmers in exchanging experiences and opinions is crucial for enhancing their links and understanding. It was a base for development of farmers' participatory approaches in extension and research. Farmers can form groups with similar interest, which may serve a basis for Farmer Field Schools and farmers' associations, guided by professional advisors (for small farmers) or networks of groups of innovative farmers (for larger scale farmers) (FAO 2013a).

A good strategy for farmers is to purchase equipment on a communal basis because usually due to high cost it cannot be afforded by single farmers. This can be done through farmer associations, extension services or machine-tractor parks. Also new equipment can be contracted for use to farmers by private entrepreneurs (Bekchanov *et al.* 2010).

Bobojonov *et al.* 2010 also argue that farmers can share expenses for purchase of expensive water saving technologies, such as laser-guided land leveling. In some districts of Uzbekistan this equipment is already available with extension services, and farmers can use it for a fixed price.

Market development

Guadagni *et al.* 2005 suggest to gradually liberalize the input and output markets in Uzbekistan, in particular by establishing quota for cotton at 50% of previous annual harvest. According to Bobojonov *et al.* 2013, the liberalization of cotton and wheat markets will lead to substantial increase in crop diversity in the country.

FAO 2013a mentions the need to develop legislative basis as well as registration and licensing of equipment for conservation agriculture. Also it states that dissemination of these practices is impossible if the equipment is not available at affordable cost. Thus, in Central Asia addressing accessibility and affordability of conservation agriculture implements is crucial, with the help of developing market linkages and local production (Paroda 2007).

Also FAO 2013a describes the way of improving supplies through farmer associations: by informing potential suppliers of inputs about commercial opportunities and encouraging them to join farmers associations for establishing direct links. Also demand in the markets for selling the output are very important and building connections with purchasers is necessary so that farmers receive returns on their efforts (FAO 2013a).

The importance of efficiently functioning supply chain and market linkages for successful growth of small farmers' production of fruit, vegetables and livestock is confirmed by Spoor 2007/10.

Credit facilities

(Swinnen unknown) claims that the most important indirect incentive for farmers of Central Asia is access to finance, because the credit constraint is the most acute.

The availability of credit is crucial for poor farmers, who even if wanted to adopt sustainable practices, do not have enough cash to pay for the needed inputs (Place and Dewees 1999).

Abdullaev *et al.* 2007 suggest that to address this issue, the government have to facilitate soft loans and other credit facilities for the cash short farmers of Tajikistan.

Juraev *et al.* 2000 suggest the total reforming of the financial system, including making commercial crediting independent, improving the attractiveness of deposits, and diversifying financial resources. At first, there is a need to develop private financial activity. Banks must analyze their credit ability and better monitor issued credits. In order to enhance bank role, some orders should be abolished, including controls, which are limiting the liquidity of deposits and promoting unfair competition. Banks should stop being dependent on the system of centralized crediting. Moreover, banks should start issuing medium-term and longterm credits.

Tashmanov *et al.* 2000 are also suggesting reform of the agricultural finance system, which should include giving farm leaders access to credit on the basis of business acumen and responsibility.

Processing and storage

Discussing the promotion of wide-scale cultivation of alternative crops, Bobojonov *et al.* 2012 argue that at first, well functioning processing and storage facilities should be developed. As a possible solution, Tashmanov *et al.* 2000 recommend purchase of processing mini-plants.

Water policy

Dukhovny *et al.* 2011 state that one of the most important components of water policy in Central Asia should be allocating responsibilities between the government and WUAs in operating irrigation networks and water supply.

IAMO 2008 recommends increasing the effectiveness of WUAs in Uzbekistan, for this purpose fully implementing the law "On integration of land users into water user associations", enhancing capacity of WUAs, ensuring training of WUA's members.

Djanibekov *et al.* 2012 suggest to alter the WUAs into business units, which would provide trainings, management services, insurancing and short-term crediting to farmers for certain fees.

Insurances

Farmers of Uzbekistan are facing many risks when producing alternative crops. In order to overcome the risk aversion behavior of farmers, protecting them from risks and increasing security of their investments should be achieved by national strategic decisions. Minimum price guarantees and crop insurance schemes might be of great help (Vlek *et al.* 2012).

Thomas 2008 suggests a need for rainfall insurance. This type of insurance works the following way: if at a specific time of the cropping season the rainfall is below a set value, all insured farmers receive payment. Another option is drought forecasts early warnings to allow farmers to be aware of rainfall outcomes in advance, before committing their resources.

State order

Guadagni *et al.* 2005 considers necessary to abolish current compulsory cropping patterns in Uzbekistan for successful promotion of sustainable agriculture in the country.

IAMO 2008 claims that strict central control of the agriculture by the Uzbek government acts as a strong constraint for rational resource use. Nevertheless, it is argued that state order system, from the other side, has its positive moments, acting as a risk minimizing strategy for farmers by providing effective system of crediting for the purposes of cultivation of strategic crops and assuring stable input prices. In this view, the suggestion is to reduce the state order for cotton,

which according to (IAMO 2008) would lead to increase in farmers' incomes, allow crop diversification and relief the land for crop rotation. Djanibekov *et al.* 2012 shares this opinion, arguing that complete abolishment of the state target could lead to substantial increase in water consumption because of potential shifting from cotton to rice cultivation by farmers.

Another recommendation from IAMO 2008 is while introducing water charges, to open domestic markets for imports, which would compensate the reduction of production volumes.

Khasanov and Djanibekov 2015 suggest shift from current cotton procurement policy with its area-based setting to quantitative targets for cotton.

Guadagni *et al.* 2005 claims that current production of wheat in Uzbekistan is substantially higher than its domestic consumption. Thus, it is recommended that the Uzbek government should allocate some area, sown by wheat, to alternative crops, for example, forages.

Planning and other policies

According to Place and Dewees 1999, sustainable agriculture should be supported by national 'umbrella' policies, stimulating adoption of sustainable practices.

Bobojonov *et al.* 2013 mentions that performing eco-friendly policies like introduction of upper limit for water use or compulsory soil salinity reductions would act as a good incentive for farmers to diversify their crop choices.

FAO 2013a describes actions suggested for Central Asia countries on the Regional Workshop on 'Save and Grow'. They include formulation of regional and national strategies and action plans for mainstreaming of conservation agriculture principles as a leading agriculture paradigm and establishment of clear policies and guidelines for agriculture, based on elements from

conservation agriculture, integrated pest and water management, and other sustainable agricultural practices.

IAMO 2008 recommends that regulations in Uzbekistan become less ambiguous in its meaning, clearly defining, for instance, the rights and responsibilities of water user associations, executive or representational powers of hokims and so on.

IAMO 2008 suggest developing administrative justice and giving independence to judiciary power in order to control the executive branch, which will help to create sustainable agricultural production in Uzbekistan.

Theoretical framework

Evolution of agricultural innovations theory

In the last 50 years of the evolution of the agricultural innovations theories, a broad range of approaches have emerged (Klerkx *et al.* 2012).

Before 1990s, the dominating opinion was that research and technology transfer were the main drivers of innovation, so-called "linear transfer of technology" model.

Rogers' diffusion of innovations theory (Rogers 2003) is an example of this approach. It explains adoption of innovative technologies by farmers and their dissemination on larger scales as a result of information exchange through communication within farmer's networks of friends, neighbors and opinion leaders. Other actors as extension services and mass media are also deemed important drivers to accelerate the process, while policies and institutional setting are considered to be external factors.

Since the beginning of 1990s, the "non-linear model of innovations dissemination" emerged, that's when the "agricultural knowledge and information system" (AKIS) concept became popular. It involved increased actors participation and financing (Pascucci and de-Magistris 2011). However, although AKIS suggests the farmers' participation in establishing research priorities is crucial, the main focus remains on the transfer of innovations from research institutions to farmers. AKIS approach regards the system as a separate entity, which can be modified by some external interventions (Klerkx *et al.* 2012).

After late 1990s, a concept of "agricultural innovation systems" (AIS) gained its importance, recognizing that innovation is an interactive process between actors with different types of knowledge within a particular institutional, political, economic and social context (Smits and

Kuhlmann 2004; Rajalahti *et al.* 2008). Since it first has been applied to agriculture, the innovation system concept received a rapid uptake for designing interventions for agricultural development.

Compared to AKIS, AIS approach puts more emphasis on the role of institutions (organisations) and active participation of actors, apart from extension services and research bodies (Hall *et al.* 2001), such as private sector entities, civil society, governmental agencies and others, who directly or indirectly influence the process of innovation development, uptake and dissemination (Veldcamp *et al.* 2008).

Agricultural Innovations Systems theory

According to the established definition, AIS represent "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" (Klerkx *et al.* 2012). Like this, innovation is an "interactive and co-evolutionary process" (Smits and Kuhlmann 2004), which involves changes of technological, economic, political, institutional and social character (Klerkx *et al.* 2012).

Within a general AIS theory body different strands of thinking have developed.

Firstly, AIS analysis have been applied on different levels: national (Van Mierlo *et al.* 2010), regional (Todtling and Trippl 2004), sectoral (Busse *et al.* 2013), and technological.

Secondly, several distinct types of innovation system analysis methods have been developed to analyse the AIS: institutional analysis, social network analysis, innovation histories, benchmark

analysis, structural system analysis, functional analysis of innovation systems and combined functional-structural analysis.

Institutional analysis

Institutional analysis explores the impact of institutional barriers and supporting factors (Hall *et al.* 2001; Clark 2002), and innovations institutionalization (Hermans *et al.* 2014) on innovation systems.

For instance, Hall *et al.* 2001 explored application of partnerships approach to institutional arrangements in agricultural development. The authors criticize neo-classical economic approach, which has linear nature: investment in research triggers the development of agricultural technology, which later is being adopted by farmers, effecting production. Hall *et al.* 2001 claim such approach fail to take into account qualitative factors that influence innovation performance, as well as the dynamics of the process over time. Moreover, authors state that in most cases innovation is happening at the interface of research and production "institutions".

Therefore, Hall *et al.* 2001 adhere to the qualitative approach, according to which hierarchical institutions and centralized agricultural research is incapable to solve the complex problems of smallholder farmers. Innovations should be a product not only of organised science, but of a whole range of actors, including farmers. Separation of scientists and farmers makes impossible establishment of productive relations, which is adverse to the R&D.

Hall *et al.* 2001 proposed a set of analytical principles for assessing innovative performance, which included the assessment of: the extent of institutional interactions; obstacles to knowledge transfer between nodes; the opportunities for and obstacles to interactive learning and institutional innovation; and policy and practices likely to cause failures of the system components.

Clark 2002 in his study of the dynamics of agricultural innovations in developing countries focuses on institutional change and institutional reform. Clark 2002 also criticizes the so-called "top down" or "transfer of technology" (TOT) model, when technological development in agriculture believed to be achieved solely with the help of centralized network of publicly funded R&D institutions, funded with central government revenues and research results being transferred to farmers through a network of extension services. He argues that little attention is paid to the tacit knowledge and local preferences of the farmers themselves and claims that traditional form of extension system is unviable and should be improved.

Social network analysis

This type of analysis highlights the importance of networks (Wielinga *et al.* 2016; Clark 2002), social linkages and collaboration (Hermans *et al.* 2014) for promoting innovations, and for enabling innovators to change socio-institutional context in favor of the innovation (Klerkx *et al.* 2010;Van Mierlo *et al.* 2010).

For instance, Clark 2002 gives much attention to interactions between actors. Moreover, he deems the key distinction of an effective innovation system from an ineffective one in how the system performs as a dynamic whole, and not so much in the presence and quality of the components of the system. However, he only refers to information and knowledge exchange. From this point, Clark 2002 finds the most crucial to be the need for well-organised and co-operative knowledge markets and maximizing the “receptivity” of receivers of information. Also he deems beneficial the contractual arrangements between private and public R&D for demand-based applied research, underlines the importance of development of participatory extension scheme, growers associations and use of NGOs to supplement public R&D efforts. The biggest problem for agricultural innovation systems development in the developing countries he

perceives the top-down character of institutional setting, which constrains the formation of such horizontal networks for knowledge development and transfer.

Smits and Kuhlmann 2004 emphasize the need to embed innovation policies in a broader socio-economic context. They urge state authorities to play an organising, but not a dominant role, giving space for other actors. The authors see clusters as a good solution for addressing systemic imperfections, particularly because they stimulate interactions within the system.

Innovation histories

This type of analysis focuses on investigating innovations development process through analysing meaningful events and cases, and the mechanisms and tools used that defined the result of these events.

For example, Smits and Kuhlmann 2004 mention the concept of "path dependency", according to which systems have a memory that influences further system development.

Klerkx *et al.* 2010 applies event analysis by investigating several case studies in Dutch agricultural production industry to assess the influence of institutional environment, interactions and random factors on the innovation process. He makes the conclusion that unintended events play a substantial role, making the character of the innovation development process highly unpredictable.

Benchmark analysis

This type of analysis is based on assessing the innovation process with the help of different types of indicators. Carlsson *et al.* 2002 were first to question how the performance of the system should be measured, emphasizing that it means to evaluate the performance of each component not as single entity, but interconnected with other components of the system. For this purpose

authors proposed different sets of indicators for mature and immature systems, based on their ability to generate, diffuse and utilize knowledge about the technology.

Carlsson *et al.* 2002 regarded innovation systems as made up of components, relationships, and attributes. In components they included actors, institutions (legislation, traditions and social norms) and physical infrastructure. Relationships represented market as well as non-market links, and attributes were regarded as the properties of both the components and the relationships. However, Carlsson *et al.* 2002 gave much less importance to the interactions (relationships) in the system, then Clark 2002, claiming that even a highly dynamic system (which has very well developed interactions) may fail, unless it evolves in the right direction.

Structural system analysis

Structural analyses looks at the structure of the innovation system and compares it with systemic failures (problems) to identify the structural element, responsible for the failure and decide on possible improvements in the structure to eradicate the problem.

For instance, Klein Woolthuis *et al.* 2005 elaborated an innovation system policy framework enabling policy makers to shape policy interventions and to evaluate successes and failures of past projects. This framework provides clear categories of failures that can occur in the technological innovation system. These types of failures were elaborated from the large number already existing and frequently overlapping categories, proposed by the scientific community in the earlier studies, and were reduced to following ones: infrastructural failure, institutional failure, interaction failure (weak network failure and strong network failure), and capabilities failure. "Capabilities' failure", according to Klein Woolthuis *et al.* 2005 express the lack of competences, capacity, or resources, experienced by the actors. As for the structure of innovation system, Klein Woolthuis *et al.* 2005 made an important emphasis on distinction between actors

(players) and institutions ('rules of the game'). Institutions, in turn, incorporate hard (e.g. regulation and law) and soft (e.g. culture and values).

Functional analysis of innovation systems

According to Bergek *et al.* 2008 and Suurs 2009, the structural analysis is not enough for analysing technological innovation systems, that's why the authors proposed functional analysis. Functional analysis focus not on the structure, but on the processes happening in the system, because they are more important for well functioning of the innovation system.

In the core of functional analysis lies assessing how well the innovation system fulfills its specific functions, which helps diagnosing systemic problems, and building policy interventions accordingly (Hekkert *et al.* 2011).

Bergek *et al.* 2008 proposed 7 functions, which include entrepreneurial activities, knowledge development, knowledge diffusion, guidance of the search, market formation, resource mobilization, creation of legitimacy. For successful development, the innovation system should properly fulfill all the functions.

Combined structural-functional analysis

Wieczorek and Hekkert 2011 proposed a new approach to studying innovation systems – by combining structural and functional analyses in one analytical systemic policy framework. The purpose of this framework is to identify systemic failures and to suggest systemic instruments for addressing the problems identified. Wieczorek and Hekkert 2011 suggest, that this systemic policy framework could help policy makers to create enabling environment for sustainable technological change, including those related to such complex issues as climate change. Hekkert *et al.* 2011 pointed that this analytical approach brought a big breakthrough in the theoretical research on innovation systems.

The framework has actively been used for assessment of innovation development processes for technologies in various sectors like energy production, electronics, information technologies etc. However, it has never been applied to innovations in agriculture. Klerkx *et al*. 2012 and other researchers consider it to be an important avenue for exploration.

Applying Wieczorek and Hekkert analytical framework for the analysis of AIS

Structure of technological innovation systems

Wieczorek and Hekkert 2011 distinct 4 types of elements in the technological innovation systems (TIS). These are actors, institutions, interactions, and infrastructure. **Error! Reference source not found.** gives explanation on the main components of the structure and provides some examples of possible structural elements of the agricultural innovation system (AIS).

Table 6. Structure of AIS

Structure	Components and examples
Actors	- farmers; - agricultural enterprises; individual farms; - agricultural cooperatives; farmers' associations; water user associations; pasture committees; community seeds funds; - knowledge/research institutes, research centers, both public and private - local governmental authorities; national level public authorities (governments, ministries of agriculture, water resources, land reclamation and other relevant; agencies); - NGOs - extension service providers, agricultural brokers and other intermediaries; - banks and micro-finance institutions; - private business entities; seed companies; - donor organisations/international organisations: national and international (FAO; WB; CIMMYT; GEF/SGP; ICARDA; CGIAR; UNDP; USAID; UNEP; GIZ; WFP; Helvetas; EBRD; ADB; IFAD; IDB; RDF; Green Climate Fund; Aga Khan Foundation etc.)
Institutions	- hard institutions (laws, policies, governmental orders and initiatives, instructions, officially prescribed norms etc.) - soft institutions (traditionally established agricultural practices and ways of production,

	habits, preconceptions about certain agricultural practices etc.)
Interactions	farmer-to farmer; farmer-extension agent; farmer – financial institution (bank); interactions in farmers' cooperative; with government; with donor organisation; research institution – extension services etc.
Infrastructure	- physical: agricultural machinery and machinery production factories; local and regional markets; roads; irrigation infrastructure; seed banks; post-harvest technologies (processing, storage etc.); meteorological stations; monitoring systems, rural banks etc. - knowledge: traditional tacit knowledge, knowledge on sustainable practices and on innovations in agriculture; meteorological data; knowledge on markets etc. - financial: subsidies; governmental financing programs, agricultural credits and loans; donors organisations grants

Source: adapted from Wieczorek and Hekkert 2011 to AIS application

Functions of TIS

In order to evaluate the quality of seven functions (defined by Bergek *et al.* 2008), a set of diagnostic questions is used: each of 7 functions is analysed through four structural elements. In such a way, if a certain function of a system is week or absent, it can be associated with a certain structural element of the AIS. And moreover, with policy decisions directed on these elements, conditions can be created, which would allow for strengthening of the function (Wieczorek and Hekkert 2011).

This means that combined functional-structural analysis has more sense and gives a clear picture of what is happening in the AIS and what is going wrong and why. That's why such analytical framework helps to obtain much more solid base for policy recommendations in comparison with using only functional analysis.

Systemic problems

Problems that hamper the good performing of the AIS are usually referred to as systemic failures (Wieczorek and Hekkert 2011).

A system consists of components, relationships between components and attributes (properties of the components). Attributes are considered properties of both components and relationships.

Actors, institutions and infrastructure are components of AIS; interactions are relationships between the components. All four elements have certain attributes.

A system failure may occur when there is a problem either with any of the structural elements (they are missing), or with their attributes: they are too intense or too week (for instance, too strong links/lack of actors capacity etc.). That's why when we identify, that AIS doesn't perform well, because there is one/several functions are absent/week, we should look into each of the structural elements of the system in order to identify why – either because of the absence of the element or because of its properties (Wieczorek and Hekkert 2011).

Therefore, systemic failures can be divided into problems related to:

- absence/presence or capacities of actors;
- absence/presence or quality of institutions;
- absence/presence or quality of interactions;
- absence/presence or quality of infrastructure.

Systemic failures, therefore, are factors negatively impacting the direction and speed of innovation processes, hampering development of AIS (Wieczorek and Hekkert 2011).

Such a 'mapping of blocking mechanisms' that might appear in the AIS, substantially increases the quality of analysis of the system. Regarding the connection between functions of the AIS and its structural elements, the improvement of the functioning requires alteration of the structure of the system. This is proposed to be addressed with the help of "systemic instruments" in the framework.

Systemic instruments

According to the above mentioned, after the systemic problems were identified, it is time to choose strategies and tools that would solve them and improve the performance of the whole AIS.

Correspondingly to existing 8 types of systemic failures, there exist 8 goals of the systemic instruments (Table 7):

Table 7. Goals of systemic instruments

Type of system failure	Goal of systemic instrument
Presence/absence of actors	Encourage/ensure participation of actors
Capacities of actors problem	Actors' capacity development
Presence/absence of interactions	Enable/stimulate interactions
Quality of interactions problem	Remove/avoid too strong and too weak ties
Presence/absence of institutions	Ensure presence of necessary hard institutions, prevent soft institutions hampering innovation
Quality of institutions problem	Avoid poorly enforced institutions or those causing "lock-in"
Presence/absence of infrastructure	Enable development of physical, financial and knowledge infrastructure
Quality of infrastructure problem	Provide adequate quality of infrastructure

Source: adapted from Wieczorek and Hekkert 2011

The goals help to choose systemic instruments and shape policy design. Each goal is related to each of the structural element. So buy selection of those goals, which correspond to "problematic" element, the functioning of AIS can be enhanced.

Systemic analytical framework

The instruments for targeting the systemic failures should be chosen in such a way that their joint work was coherent and reinforced each other's effect. The sense of it is to trigger development of

the links between the elements which could not emerge spontaneously (Wieczorek and Hekkert 2011).

Figure 16 shows the stages of the systemic analytical framework application.

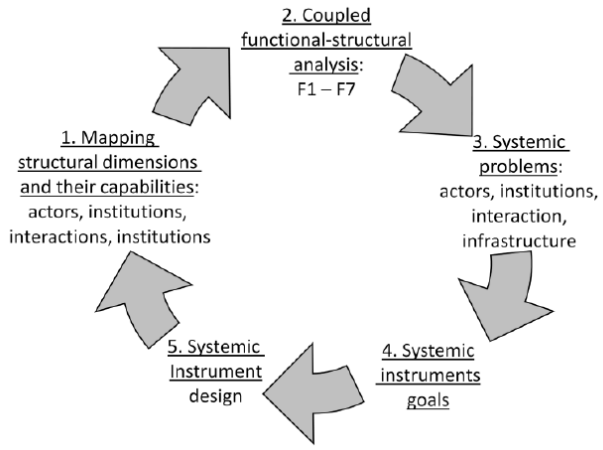


Figure 16. A systemic analytical framework for TIS

Source: Wieczorek and Hekkert 2011

Stage 1 - Mapping structural elements and their capacities

In the beginning the mapping of structural elements of TIS should be done and their capacities should be described with the help of literature review, internet search, and qualitative interviews (Wieczorek and Hekkert 2011).

Stage 2 - Combined functional-structural analysis

According to Wieczorek and Hekkert 2011, this stage starts with a functional analysis of the system. All seven functions should be analysed through specially developed diagnostic questions.

Stage 3 – Identification of systemic failures

Analysing consecutively each function, it is necessary to identify the structural element/elements, which causes the weakness or absence of the function. Based on this analysis, the systemic failures, that hamper the development of the AIS, are formulated (Wieczorek and Hekkert 2011).

Stage 4 – The formulation of goals of the systemic instruments

Systemic failures identified serve for formulation of specific goals of systemic instruments and policy recommendations, which will help to enhance the development of AIS (Wieczorek and Hekkert 2011).

Stage 5 – The Designing of systemic instruments

In order to target the goals of systemic instruments, some of already existing policy tools can be used. But their choice depends not only on the systemic failures, but also on the context, on interactions between selected instruments, on competing AISs etc. Like this, an integrated systemic instrument can be designed, which is a set of tools for a specific AIS. The purpose of such instrument is enhancing the elements of the system and creating opportunities for formation of links between them, which would not "otherwise emerge spontaneously" (Wieczorek and Hekkert 2011). This idea was also supported by Borras and Edquist 2013, who claimed that policy instruments become systemic only when they are combined in "policy mixes", able to address complex and multiple causes of systemic problems.

Critical analysis of the other comprehensive analytical frameworks

Analytical frameworks for analysis of problems in AIS have been proposed by several authors (Klein Woolthuis *et al.* 2005; Van Mierlo *et al.* 2010; Amankwah *et al.* 2012 and others). However, relatively few of them constitute a comprehensive framework for whole system

analysis, which is suitable for construction of systemic policy instruments, as the one developed by Wieczorek and Hekkert 2011. They will be described and criticized in this section.

Rajalahti *et al.* 2008 has elaborated a workable (analytical and intervention) framework for agriculture based on the innovation systems concept. The four elements of the analytical framework included key actors and their the roles/activities; their attitudes, including their views on collaboration and their culture of innovation; patterns of interaction among actors; and the enabling environment, including policies and infrastructure. The intervention framework by Rajalahti *et al.* 2008 consists of a set of principles to address the weaknesses of innovation capacity in each phase of system development, and of possible options for intervention derived from case studies.

Rajalahti *et al.* 2008 distincted two innovation pathways for the system: an orchestrated trajectory and an opportunity-driven trajectory. The orchestrated trajectory includes pre-planned, foundation, and expansion phases of development of the system, and the opportunity-driven trajectory consists of the nascent, emergence, and stagnant phases. Meanwhile, Rajalahti *et al.* 2008 saw the final phase of agricultural innovation system development as a dynamic state between these two trajectories, and argued it can be established with the right type of support.

The framework, proposed by Rajalahti *et al.* 2008, has however several weaknesses. First of all, there is no explanation given on the diagnostic features that should be used in order to identify the phase of development of the agricultural innovation system in question. Secondly, the framework is claimed to help identify systemic strengths and weaknesses of the system, but doesn't contain a defined procedure for this. Also, although authors claim it can be adapted to specific phases of development and to local conditions, they don't say how it can be done.

Moreover, interventions proposed are based on existing experiences from the case studies, which raises the question of applicability to the local context.

Another framework, Rapid Appraisal of Agricultural Innovation Systems (RAAIS), was proposed by Schut *et al.* 2015. RAAIS is a diagnostic tool that was developed specifically to guide the analysis of the agricultural systems, their innovation capacity and agricultural problems they might have. RAAIS builds upon existing agricultural innovation system concepts and has comprehensive selection criteria for methods of data collection. Usually combining multiple methods, the tool integrates insider (stakeholders) and outsider (researchers) analyses and allows for critical triangulation and validation of the gathered data (Schut *et al.* 2015).

Through analysis of multiple dimensions the AIS (such as technological, socio-cultural, economic, institutional, political etc.); interactions across national, regional, local levels, and interests of different stakeholder groups, the tool explores of the innovation capacity in the agricultural system, and the functioning of the agricultural innovation support system. As a result it provides specific entry points for innovations targeting systemic problem under study, and generic entry points for innovation for enhancing the performance of the agricultural innovation support system.

However, when identifying complex agricultural problems, RAAIS relies only on structural analysis of actors and interactions. Institutions and infrastructure are only present in the framework as the elements of the institutional and technological sub-systems which might be and might not be present in the AIS together with the sectoral sub-system for analysis of the innovation capacity of the agricultural system.

The analysis of the agricultural systems support system again focuses on institutions, infrastructure and actors, duplicating the analysis if the innovation capacity of the system.

Therefore, the construction of the analytical framework is cumbersome with multiple duplications in the structure. The whole process of how the analysis should be performed and the systemic problems should be identified is unclear, and the procedure for selecting the solutions of the problems identified is absent.

Specific and generic entry points for innovations have a logical grain, however the procedure of their selection is vague and doesn't allow to understand interactions between agricultural system problems. The prioritising of actions is absent. Moreover, generic entry points, having more general character often duplicate the effects of specific entry points, thus the whole volume of interventions required to address all the points turns out to be high and hard to implement if the time frame and resources available are limited.

Lamprinopoulou *et al.* 2014 constructed the analytical innovation systems framework, analysing systemic structures, functions, failures and merits of innovation systems, and applied it for assessing of the agricultural innovation systems of Scotland and the Netherlands. The framework was constructed based on analytical framework of Wieczorek and Hekkert 2011, plus it included 5 additional types of failures: market structure failure, directionality failure, policy coordination failure, demand articulation failure, and reflexivity failure.

I argue, however, that those added failures don't bring any additional value neither to the assessment procedure, nor to the resulting analytical findings. In opposite, they make the framework bulky and the assessment process too cumbersome. In reality, all 5 failures are just doubling failures already present in the W-H framework:

- "Market structure failures" is absence/presence or quality of market infrastructure;

- "Directionality failure" might involve poor capacities of actors (government) or interaction failure (government-change agents);
- "Policy coordination failure" relates to interaction failures at different policy levels or among sectors;
- "Demand articulation failure" means absence/presence or quality of interactions failure between agricultural producers and scientists;
- Finally, "reflexivity failure" relates to capacities of governing actors' failure to effectively monitor progress against the goals, and to adjust the strategy accordingly.

Given the discussion above, the Author of this research decided to select Wieczorek and Hekkert 2011 framework for TIS analysis as the base for building the specific analytical AIS framework for the analytical purposes of this research. The simplicity, clear logical order, absence of overlapping procedures and doubling efforts make it very appealing and practical. However, the necessary adjustments will be made to the W&H framework to adapt it for the use in agricultural innovation systems analysis, plus several improvements will be proposed, on which details can be found in the chapters "Construction procedure of the holistic systemic instrument" and "Theory added value" of this dissertation.

Methodological framework

Taking into account the specificity and structure of the theoretical analytical framework adopted for this research, there was a need in a specially constructed methodological framework, that would address the questions under study, target needed stakeholder groups and combine multiple methods of data collection. As such methodological framework, a methodology of the Rapid Appraisal of Agricultural Innovation Systems (RAAIS) tool was adopted, with several modifications to better fit the needs of the research.

RAAIS was developed for analysis of agricultural innovation systems and problems existing in them. This analytical tool is designed to identify constraints across several dimensions and levels of the agricultural system, and to assess the functioning of the "agricultural innovation support system". Based on this it provides "specific entry points" for agricultural innovations aimed to solve a problem in the system, and "generic entry points" for innovations with the aim to enhance the innovation capacity of the agricultural system and to improve performance of the agricultural innovation support system (Schut *et al.* 2015).

While RAAIS conceptual framework (Schut *et al.* 2015) was considered too cumbersome by the Author, and a different one was developed to serve the purposes of this study, its methodology was considered very comprehensive and well suited for the aims of the research analysis.

RAAIS integrates both insider's (stakeholders) and outsider's (researcher) analyses and uses a combination of methods, which altogether allows for critical triangulation and validation of data. It has been validated through several studies, for example in Tanzania and Benin to diagnose parasitic weed problems in the rice sector, and others.

According to Schut *et al.* 2015, there are several important criteria for selection of methods of data collection for the analysis of agricultural innovation systems:

1. Methods should include analysis by both 'insiders' and 'outsider'. Insiders (different groups of stakeholders) usually possess specific knowledge based on their experiences directly with the problems in the system. Nevertheless, they often lack a broader understanding or critical view of the system in general. For this reason, there is a need to analyse the collected insiders' analytical opinions by a researcher (outsider).

2. Methods should target different actors' groups in order to include in the analysis all the variety of perspectives and experiences.

3. Methods should approach stakeholders both individually and in multi-stakeholder groups. Group discussions in diverse groups can provide rich data on constraints and potential solutions for complex problems in agricultural systems. At the same time, some stakeholders might feel pressure/fear to speak in the presence of others because of certain type of relationships among stakeholders involving authority/dependence specifics. That's why methods should target stakeholders individually as well.

4. A methods combination should provide detailed enough data to describe the problems in the agricultural system under study. It would also allow to ensure triangulation and validation of data.

Corresponding to these criteria, the following complementary methods of data collection were selected for this research (Table 8): online questionnaire, expert focus groups (during the multi-stakeholder workshop), semi-structured interviews with farmers, in-depth interviews with selected experts, secondary data analysis, legislation and policy analysis.

Table 8. Correspondence of selected methods of data collection to the selection criteria

Criteria / Method	Type of analysis		Stakeholders						Groups vs Individual	
	Insider	Outsider	Govern ment	NGOs/ CSOs	Experts	Acade- mia	Exten- sion	Farmers	Groups	Indivi- duals
Questionnaire	✓	✓		✓	✓	✓		✓		✓
Focus groups	✓	✓	✓	✓	✓	✓			✓	
Interviews	✓	✓	✓	✓	✓	✓	✓	✓		✓
Policy analysis		✓	N/A						N/A	

Multi-stakeholder workshop

According to Schut *et al.* 2015, one of the most efficient ways to identify and analyse constraints in the agricultural system, is organisation of a multi-stakeholder workshop, during which several types of data collection can be performed, both individual and in homogeneous and heterogeneous groups. The important conditions should be inclusion of stakeholders from different groups and levels (for instance, local, national, regional), use of language(s) understandable to all the participants and facilitation by a person with common/similar culture and familiar with a problem.

All the conditions were satisfied due to the opportunity provided by the Food and Agriculture Organisation of the United Nations (FAO), during the Central Asian workshop on Climate Smart Agriculture in Bishkek (Kyrgyzstan), which was designed to take 3 days (from 12th to 14th July, 2016). The workshop brought together national, regional and international experts and stakeholders, and was aimed at identifying gaps and barriers, needed technical and knowledge support to facilitate uptake of climate smart agriculture in the region of Central Asia. The workshop was organized by Food and Agriculture Organization of the United Nations (FAO) together with Regional Environmental Centre for Central Asia (CAREC), International Center for Agricultural Research in the Dry Areas (ICARDA), Central Asia and the Caucasus Association

of Agricultural Research Institutions (CACAARI), Global Alliance for Climate Smart Agriculture (GACSA), Central European University (represented by the Author of this dissertation).

Expert focus groups

Several of the workshop sessions proposed by Schut *et al.* 2015 were slightly modified to adapt to existing circumstances and context, and during these sessions focus groups with experts from different countries of Central Asia were conducted.

The Author of this research together with another consultant from FAO have developed the template for these sessions, and included the questions of interest for this research (Table 9).

Table 9. Focus groups' sessions, objectives and activities

Session №	Question of the session	Objectives	Activities
1	What do you consider the main barriers to make the needed transitions to a CSA approach?	To create a list of constraints in the agricultural system faced by the stakeholders, and to identify 5 most important among them in the opinion of the participants.	Working in focus groups by country, participants name the factors constraining the transition to CSA. Participants prioritize the constraints from the list, selecting 5 most important.
2	What could be the possible enabling environment interventions to overcome these barriers?	To explore possible enabling environment solutions for overcoming the constraints identified.	Working in the same groups, participants brainstorm, what kind of enabling environment is needed for overcoming the constraints in the agricultural system
3	What are important government, donor or regional finance mechanisms or incentives to be considered to support the implementation of a CSA approach?	To explore different types of mechanisms, which could facilitate transition to CSA in the respective countries	Participants discuss in groups the existing mechanisms of different types for enabling, facilitating and supporting the transition to CSA, potentially applicable to the respective countries in Central Asia

Focus groups with experts were held on 12th and 13th July, 5 focus groups on each day (10 in total). Each focus group lasted for 1,5 hour and was comprised from experts from one country of Central Asia (Table 10). Like this, the groups were heterogeneous, because included several

groups of stakeholders (governmental officials and experts from line ministries, non-governmental and civil society organisations, extension agents, independent experts and academia), and homogeneous in a sense that included only one-country expertise per group.

Table 10. Expert focus groups composition

Focus group	Date	Country	Number of participants
1	12.06.2016	Kazakhstan	8
2	12.06.2016	Kyrgyzstan	18
3	12.06.2016	Tajikistan	11
4	12.06.2016	Turkmenistan	3
5	12.06.2016	Uzbekistan	13
6	13.06.2016	Kazakhstan	8
7	13.06.2016	Kyrgyzstan	15
8	13.06.2016	Tajikistan	11
9	13.06.2016	Turkmenistan	5
10	13.06.2016	Uzbekistan	11

All the groups were facilitated by the national FAO stuff (apart from the "Uzbekistan" group, which was facilitated and moderated by the Author of this research). Besides the facilitators, a note-taker was selected in each group to document the results of the group discussions. The general discussion among all the participants was also audio recorded.

Workshop sessions facilitation guides developed by the Author, note-taking protocols and audio recordings of focus group discussions have ensured that the session outcomes are standardized, which is important for comparison of the results across different countries of Central Asia.

Semi-structured in-depth interviews

According to Schut *et al.* 2015, interview respondents should be sampled to represent different stakeholder groups and different locations under study. The size of the sampling ideally should allow "saturation", when further interviewing doesn't bring any new information. A preliminary flexible list of questions should be prepared as guidance for the semi-structured interviews, which can be fine-tuned during the process.

Correspondingly to Schut *et al.* 2015, some of the semi-structured interviews were conducted during the Central Asian Climate Smart Agriculture workshop in June 2016 and targeted the same experts, which took part in the focus groups, but included more topics and were specific to the experts' country of origin and work experience/expertise.

The other interviews were conducted in May – June 2017 during the field research trip to Kyrgyzstan. These interviews were more in-depth and targeted selected respondents from corresponding stakeholder groups, they lasted from 1 to 5 hours, and had more rigid structure, built upon the analytical framework developed for this research.

As recommended by Schut *et al.* 2015, the selection of interview respondents was sometimes targeted, when certain respondents were chosen for their acknowledged expertise; and "snow ball" sampling when respondents recommended the next suitable candidates for the interviews (Schut *et al.* 2015).

Interviews were audio recorded, and the electronic transcriptions were coded.

Interviews with experts

In interviews with experts, as well as in expert focus groups, the knowledge of the respondent is the subject of the discussion. The interviewee is seen as a representative of a distinct group with undisputed knowledge about a certain field of interest (Romer 2005).

The experts interviewed in June 2016 represented all 5 countries of Central Asia, as well as different groups of stakeholders - government officials, national and international organisations working in the region, NGOs, research institutes etc. The 2d round of interviews with experts, held in May-June 2017, involved such stakeholder groups as academia and research institutions, extension services agents, and local government officials.

The interviews with experts were held in Russian and English. The flexible set of questions used for the interviews is provided in the Box 1.

Box 1 – Set of questions for the interviews with experts

1. *What is the variety of CSA options? How many types of practices are used/on which area?*
2. *Are there many farmers using CSA practices?*
3. *To what extent farmers are willing to experiment?*
4. *Are any farmers abandoning the practices?*
5. *Is new adoption happening?*
6. *What types of stakeholders are involved in adoption and upscaling of CSA?*
7. *Does CSA/SLM get attention in the research in countries of Central Asia?*
8. *Do farmers and other agricultural producers in CA use these knowledge/is their number sufficient?*
9. *Does strong partnerships for knowledge dissemination on CSA exist and between whom?*
10. *Is there a strong competition with conventional practices and preconceptions?*
11. *Do farmers have access to knowledge on effects of climate change/CSA practices?*
12. *Is CSA included in special policies and programmes? In governmental activities?*
13. *Is there a market for CSA inputs/outputs in the countries of CA? Is it well developed or not?*
14. *Is there a need for creation of new markets?*
15. *Are there enough financial resources for the dissemination of CSA practices in CA? How are they used (research/pilot projects/upscaling etc.)?*
16. *Is the public funding adequate?*
17. *Can farmers easily access the resources?*
18. *Are credit/microcredit systems developed and available for farmers?*
19. *Is there a system of insurancing of risk in place?*
20. *Is there much resistance to change from conventional agricultural practices to CSA practices? Where from?*

Interviews with farmers

The decisions about allocation of resources are mostly done on the level of households (Romer 2005). Sustainable practices investment decisions are evaluated by farmers and agricultural entrepreneurs based on key external factors including: access to markets; availability of support and extension services; access to knowledge and information; regulations and policies, etc. It is recognised that farmers do not use a linear decision making process – they consider many factors simultaneously (Romer 2005).

This research sought to obtain a qualitative insight into decision-making at the household level, and not to perform a representative quantitative analysis based on statistical evaluations. Therefore, only 6 sites in Kyrgyzstan were selected for sampling of the interview respondents. These sites, however were situated in the historically most innovative provinces – Chuy and Issyk-Kul – of the country. It's in these places that the majority of donor-funded innovative projects in agriculture were implemented, and several climate smart practices were adopted by a number of farmers. The locations were situated at a relatively small distance from each other (in the scale of the country), which allowed also to roughly estimate whether the dissemination of the implemented practices is happening or not, and why.

For each site, the number of households interviewed was fixed at a number of 4, without consideration of the village size. The selection was based on the household categories – farmers were selected from each category: poor, average and rich. The categorisation was based on subjective judgement of a village member.

In the period May – June 2017, 24 interviews with farmers were conducted. The oral semi-structured interviews were based on a flexible set of questions prepared in advance (see Box 2). A substantial number of fields were also visited.

Box 2 - The preliminary question list for the interviews with farmers

1. *Do you know about how climate change affects your crop yields and production levels? Do you know what sustainable agriculture is? Have you heard about climate smart agriculture practices?*
2. *Are there any services in place that disseminate knowledge in your village about innovative farming practices? About sustainable farming? About climate smart agriculture? How often do they contact you? Do you take part in such events?*
3. *Which new sustainable practices were implemented in your village? How did it effect your yields/income? Did you find these innovations useful?*
4. *Do you still use these practices? On bigger/smaller scale? Why/why not? If not, what do you think might make you change your mind?*
5. *Are you able to buy machinery/seeds/other inputs needed for this CSA practice? If yes, from whom? Are they easily accessible?*
6. *Where do you sell your produce? Are there many markets to sell it? Is it easy? Are the prices adequate?*
7. *Can you take a credit/microcredit for your agricultural production? Under which interest rate? Are there any subsidized credits available?*
8. *Does the Government support farmers? Is there any state support for sustainable agriculture available?*

Online survey

Schut *et al.* 2015 notes that some types of constraints might be identified by only particular groups of stakeholders, so for obtaining the broad picture the use of surveys might be helpful. The authors suggest that data collected with this method can be complementary to workshops and interviews, and recommend conducting it after the mentioned methods.

However, it was decided that such surveys should be conducted before the workshop, so that the results are analysed, and the preliminary picture is obtained before conducting focus groups and interviews. The reason for such order was twofold: firstly, it helped to adjust the questions in focus groups and interviews, and to facilitate the discussion to lead it in the needed direction; and secondly, due to cultural context in the countries of Central Asia, people at times are reluctant to speak, that's why providing them with some examples of other peoples' opinions helped participants start the discussion and share their own views.

The online survey "Central Asia activities on Climate-Smart Agriculture" was a joint activity of the Regional Office for Europe and Central Asia of FAO UN with a substantial contribution of the

Author of this research, who used the opportunity to include the questions of interest to this research. It generated an important data based on the rich experience of national experts from Central Asia, as well as international experts working in the region.

The questionnaire was available in English and Russian, from 30th May 2016 to 17th June 2016 on the site of FAO (http://www.fao.org/fsnforum/eca/activities/online-surveys/CSA_ECA).

The total number of respondents was 131 from 28 countries, from those 15 respondents from Kazakhstan 29 - from Kyrgyzstan, 27 - from Tajikistan, 18 - from Uzbekistan, and only 2 from Turkmenistan. The responses from Turkmenistan were not analysed due to their unrepresentative number.

The respondents were asked a number of questions, those included by the Author of this research are shown in the Box 3.

Box 3 – Questions from the online questionnaire

Question 1: What do you consider as the main socio-economic constraints for transitioning to more sustainable, resilient and efficient production systems?

1. Poverty
2. Limited access to land/land tenure related
3. Lack of access to input market
4. Lack of access to output market
5. Limited access to credit, insurance etc.
6. Lack or limited access to information related to socio-economic mechanisms (credit, insurance, etc.)
7. Lack of limited access to extension services
8. Lack or inadequate social protection schemes including insurance, social safety nets
9. Limited capacity to absorb knowledge & information as a result of limited years of formal education
10. Limited availability of labour, due to e.g. (youth) migration

Question 2: What do you consider as the main policy and institutional constraints for transitioning to more sustainable, resilient and efficient production?

1. Lack of state management/legislation in agricultural production and decision making at all levels.
2. Absence of relevant laws, policies, plans, strategies to enable improved planning.

3. Lack or limited institutional cooperation, collaboration and communication among relevant stakeholders to ensure effective and efficient implementation.

4. Lack or limited human resources and capacity to conduct research and absorb knowledge and information.

5. Lack or limited institutional planning capacity

6. Lack or limited community organization and involvement with regard to agriculture

7. Lack or limited available mechanisms for knowledge sharing and capacity building to transfer knowledge to farmers, extension services and other related entities

Question 3: Based on the main constraints identified, please select 4 policy and institutional support mechanisms needed to overcome barriers and allow for rural development transitions:

1 - Identify key stakeholders in setting up national CSA programmes

2 - Formulate cross sectoral policies to support CSA

3 - Decision tools for prioritizing CSA investment options

4 - Increasing investment in research capacity on CSA

5 - Analysis of the enabling environment/barriers to adoption

6 - Building stronger links between agriculture & other sectors

7 - Strengthening farmers' inclusion and leadership in CSA knowledge systems

8 - Providing better links and support for market access to farmers and shortening the value chain

9 - Providing incentives for private sector leadership on CSA innovation

10 - Individual capacity development and technical assistance for the adoption of new practices / technologies

11 - Organizational / institutional capacity development to improve coordination between CSA relevant stakeholders

12 - Support performance of cooperatives / producer organizations to further adoption / uptake of CSA practices

The obtained responses were processed and the corresponding percentages of choices were calculated for each constraint. Based on this, graphs were built for each country (see

Annex B – Results of the online questionnaire).

Secondary data collection

Schut *et al.* 2015 considers secondary data analysis to be quite useful for the analysis of agricultural systems, to supplement other data collection methods.

Such key secondary data as legislation and policy documents were included for the purposes of this research, in particular for the analysis of the Function 4 performance of the system (see Table 17, Table 18, Table 19). The insights from policy and legislation analysis were verified through focus groups and interviews, in particular to what extent the laws and strategies were implemented and enforced.

Secondary data analysis continued throughout the research process.

Benefits of the selected methodology

The combination of methods selected proved to be successful in achieving its objectives – collecting ample, detailed and reliable data for analysis of the agricultural innovation system of climate smart agriculture in Central Asia, especially in Kyrgyzstan, where the improved analytical framework was applied.

The benefits of the research methodology are the following:

- Combination of several methods allowed for triangulation of data, which ensured better validity and credibility of the results.
- Participation of different stakeholder groups was crucial for strengthening the research quality and validity, it also helped to get assessments of the system from different perspectives, which at times varied considerably.

- It also helped to get the insights on how feasible and acceptable different stakeholders consider the possible solutions to the problems.
- The focus groups and the questionnaire only showed a static snap-shot of the real picture, while continuous policy analysis and especially in-depth interviews, which where held in consecutive years, presented a more dynamic image of the evolving system.
- Specific cultural norms and authority relations might have affected results of discussions in focus groups, but individual interviews allowed respondents to speak more freely and discuss sensitive topics.
- The modified sequence of methods was essential, the online survey, performed first, allowed to obtain first insights on the problems in the system and on possible solutions, which were then verified by focus groups. The in-depth interviews then provided detailed information on the underlying causes and constraints existing in the system.

Results and analysis of AIS in Kyrgyzstan

Mapping of structural elements

The results of the analysis of actors, relevant for adoption, dissemination and upscaling of climate smart agriculture in Kyrgyzstan is shown in the Table 11, Table 12, Table 13, and Table 14.

Table 11. Governmental bodies of the Kyrgyz Republic (of relevance to CSA)

Institutions	Responsibilities
Zhogorku Kenesh (Parliament)	The competence of the Zhogorku Kenesh of the Kyrgyz Republic, among other functions, includes the annual approval of subsidies for irrigation and drainage (within the framework of the state budget), as well as the establishment of water use fees.
Ministry of Agriculture, Food Industry and Land Reclamation of the Kyrgyz Republic	It is the central governmental executive authority that implements the national policy on agriculture, land and water resources, irrigation and land reclamation infrastructure and processing industry. Objectives (among others) include: - Development of national agricultural policy; - Ensuring sufficient agricultural production for satisfying internal needs and increasing export; - Identifying priorities for development of innovative research, and facilitating adoption of scientific and technical innovations by producers; - Interstate allocation of water resources and joint control of the interstate water relations; - Performing land conservation and soil protection from degradation.
Ministry of Economy	It is the central body of executive power, exercising (among other things) the development and implementation of state policy in the field of tariff, licensing, fiscal policy and trade.

Institutions	Responsibilities
Ministry of Education and Science	It is the central body of executive power that develops a unified state policy in the field of education, science and scientific and technical activities, and exercises state control over the accessibility and quality of education and knowledge.
State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic (SAEPF)	It is a state body in the system of executive power that provides functions for implementing a unified policy in the field of environmental protection and rational natural resources use and management.
The Agency for Hydrometeorology of the Ministry of Emergency Situations of the Kyrgyz Republic (Kyrgyzhydromet)	It is subordinated to the Ministry of Emergency Situations of the Kyrgyz Republic, responsible for: - monitoring of the natural environment to protect the population from natural hydrometeorological phenomena, preventing or reducing damage that may be caused by them; - forecasting dangerous and spontaneous hydrometeorological phenomena, issue of forecasts of water availability in rivers and water inflow to reservoirs, agrometeorological forecasts; - meeting the population's needs for hydrometeorological information.
Department of Water Resources and Land Reclamation of the Ministry of Agriculture, Food Industry and Land Reclamation of the Kyrgyz Republic (DWRM)	It is the subordinate subdivision of the Ministry of Agriculture, Food Industry and Land Reclamation of the Kyrgyz Republic that provides management, monitoring and regulation of the state and use of water resources, irrigation and meliorative infrastructure facilities, and carries out executive, administrative and coordinating functions to implement the unified state water policy.

Table 12. Local government and community organizations (of relevance to CSA)

Institutions. Interest groups	Responsibilities
Village Keneshes (rural administrations)	The system of local self-government bodies is formed by: 1) local keneshes - representative bodies of local self-governance; 2) aiyl okmotu, city halls - executive bodies of local self-governance. The executive bodies of local self-government and their officials are accountable to local keneshes in their activities.
Zhayyt (pasture) committees	Zhayyt Committee is the executive body of the association of pasture users. According to the Law of the Kyrgyz Republic "On pastures" (2009), all pastures are managed by pasture user associations
Farms and cooperatives	The (peasant) farm is an independent economic entity that has the status of a legal entity or carries out its activities without creating a legal entity, whose activities are based primarily on the personal work of members of the same family, relatives and other persons who jointly produce agricultural produce, based on land and other property belonging to members of the farm on the right of joint ownership or rented. In the case of the creation of a farm as a legal entity, it is a commercial organization.
Water-users associations (WUAs)	Responsible for operation and maintenance of on-farm irrigation infrastructure and delivery of irrigation water to water users

Table 13. Scientific and educational institutions of the Kyrgyz Republic (of relevance to CSA)

Institutions	Responsibilities
Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic	The Institute's activities include conducting fundamental scientific research and applied developments in the field of rational use of water potential.
Kyrgyz National Agrarian University named after I.Skryabin	The University conducts training of scientific and pedagogical personnel in the areas of: agronomy and forestry, engineering and technical management of natural resources, veterinary medicine and biotechnology, technology and processing of agricultural products, economics and business, innovative technologies. Contains 4 research institutes (Research Institute of Agriculture, Research Institute of Veterinary Science, Research Institute of Irrigation, Research Institute of Livestock and Pastures) as part of it.
Kyrgyz Research Institute of Agriculture at the Kyrgyz National Agrarian University named after I.Skryabin	Project development, agricultural engineering, agronomy, agriculture
Kyrgyz Research Institute of Animal Husbandry, Veterinary Medicine and Pastures at the Kyrgyz National Agrarian University named after Skryabin	Project development, consultations in livestock breeding, agriculture, production and processing of food and beverages; Scientific fundamental and applied research in agriculture, on agricultural chemicals, on fodder for livestock, soils etc.
The Kyrgyz Scientific Research Institute of Irrigation at the Kyrgyz National Agrarian University named after I.Skryabin	Conducts scientific research in two areas: "Melioration and irrigated agriculture" and "Technical and information support"

Table 14. Private sector and civil society organizations (of relevance to CSA)

Institutions	Responsibilities
International Business Council (IBC)	The organization, uniting about 150 leading companies with foreign and local capital in the Kyrgyz Republic, was established in year 2000. IBC is working to improve the country's investment attractiveness and create an enabling environment through the establishment of a dialogue between the public and private sectors, and the organization of regular round tables and committee meetings. The IBC actively supports the process of economic reforms and ensures the participation of representatives of the private sector in public policy activities.
Farms, agricultural cooperatives and family farms	Main agricultural producers; land- and irrigation water users; direct beneficiaries from agricultural adaptation projects; central unit for adoption and use of climate smart agriculture practices.
Ltd "SAB"	Supply of equipment for greenhouses, drip irrigation systems and equipment, mulching plastic film
Climate Change Center	The Climate Change Center of the Kyrgyz Republic (CCC) was established in 2005. The main goal of the Center is to assist the country in fulfilling its international obligations and national measures in the field of climate change. The main activities include: - development and participation in the implementation of climate change concepts, programs and action plans; - organization and implementation of scientific and methodological, research and engineering work on adaptation and mitigation of climate change risks; - Support to the authorities in the development of legislative and regulatory documents in the field of climate change.

Institutions	Responsibilities
	Potential for creation of enabling environment for CSA in the KR.
Vetservice	The goal is to supervise and control the safety of animal life and health and to implement antiepizootic measures
Rural Advisory Service (RAS)	To meet the needs of agricultural cooperatives and other producers in the information and advisory services, the Rural Advisory Service and the Kyrgyz Agro-Industrial Market Information Service were created, funded by the World Bank

Combined structural-functional analysis

Function 1. Farmers' innovative activities

The variety of climate smart agriculture methods practiced by farmers in Kyrgyzstan is not big, and mostly is represented by 3 groups of practices:

- innovative CSA options implemented in the country by international and national non-governmental organizations through donor-financed projects. These are conservation agriculture (zero- and minimal tillage, direct seeding), drip irrigation, mulching with plastic film etc.
- methods, developed and promoted by national research institutions (for instance, by Kyrgyz Agrarian University and Kyrgyz Institute of Irrigation), which can be categorized as climate smart due to its resources-saving and production increasing characteristics. Such methods include contour irrigation, irrigation of seeded furrows, shortened furrows etc.

- traditional practices, which can be considered climate smart, and which were used by farmers of Kyrgyzstan during decades, but might happen to be forgotten with the intensification of agriculture during soviet times. Among them are such practices as planting windbreaks, growing trees on rocky soils, irrigation with plastic bottles etc.

The description of the above mentioned technologies can be found in the Annex A.

Normally, there should be one more group – CSA practices, which implementation is supported by the state. But this group, as informants claim, is almost absent in Kyrgyzstan. According to one national expert in the field, the Kyrgyz government is making certain efforts to introduce drip irrigation by creating conditions for crediting farmers to buy equipment for drip irrigation. Former FAO representative in Kyrgyzstan states that organic production became wide spread in the country due to the government efforts, who has plans to reach 100% country scale, and the expert deems it very likely to happen. However, the majority of respondents agreed on the fact that agricultural sector and farmers in general, and climate smart agriculture in particular, receive very poor state support (if any). Because of the lack of evidence on state-supported interventions on the rest of CSA practices in Kyrgyzstan, it was decided not to create a separate group for them.

The most widely distributed and applied climate smart practices in Kyrgyzstan appeared to be those, which satisfy the following 3 criteria:

- don't require high capital investments and are cheap in exploitation;
- help saving resources like water, fertilizer, seeds or labour;
- help to increase yields, or maintain the same level of yields while considerably lowering costs.

A farmer from Studencheskoe village explained his choice of innovative agricultural methods as follows: *"We were trying to implement something for, first of all, decreasing the costs, saving the soil fertility, that's why we were looking for low-cost technologies, which could ensure better water distribution, and at the same time to get good yields and good quality of produce."*

Drip irrigation, according to the agrarian research expert, is currently *"coming to the fore front in the country because of climate change"*. A local government representative informed that drip irrigation is being used in many locations in Kyrgyzstan – in Chui and Isyk-Kul provinces, and is especially popular in Osh province, for irrigating fruit gardens, berries and melons. Confirming these data, another national expert in irrigation gave examples of apricot gardens in Issyk-Kul, fully irrigated with drip irrigation, he also mentioned the vineyards in the most remote southern Batken district, situated on the border with Tajikistan. According to him, drip irrigation technology was implemented there long ago in soviet times on the plots of 40-50 ha. After the collapse of the USSR, these plots were distributed and separated among several farmers, which largely led to abandoning of the technology. In Chui province there are initiative farmers who adopted drip irrigation on the plots of 200-300 ha, where they grow maize and sugar beet. But mainly it has point pattern.

Indeed, according to the official data provided by the agriculture division of Issyk-Atinsk district administration, drip irrigation is implemented on 746 ha in Kyrgyzstan. But latest estimates, mentioned by the expert, suggest that this number reached 2000 ha. In any case, this is too little for a country with 1280600 ha of arable land (WorldBank 2018). A number of informants explained this by several reasons: high installation and maintenance costs, inapplicability to small-sized plots of 1-2 ha, which the majority of farmers have in Kyrgyzstan, and low resulting savings because of low water tariff charges in the country.

Instead, local research institutes promote improved furrow irrigation methods (with shortened furrows allowing to save considerable amounts of water) and sprinkler irrigation, which according to their calculations brings water-savings comparable to such with drip irrigation, and at the same time doesn't require high capital investments.

Several traditional irrigation techniques are widely used in the south of the country, where the land inclination is high, to prevent soil erosion. These are:

- Contour irrigation, when the furrows are cut in such a direction towards the slope so that to achieve zero or almost zero inclination – *"It is an old method, very well known. We've just begun to recall it."* (expert from Kyrgyz National Research Institute of Irrigation);
- Irrigation of seeded furrows – *"The seeded area is much bigger because the sides are also seeded, plus when the root system is formed, it doesn't allow more for erosion"*
- Cutting and irrigating alternate furrows – *"there are 30 % less furrows and 30% less water consumption"*.

The expert also mentioned that another method – fertigation (introduction of liquid fertilizer) was used before, but which currently is possible only for drip irrigation systems. Solid fertilizers, the only supplied in the country, are usually just thrown by farmers on the soil, and later the surface irrigation is applied.

Conservation agriculture, so popular in the neighboring Kazakhstan, receives very little application in the Kyrgyz Republic. There are very few cases of application of separate practices, comprising the whole method: minimal/zero tillage, direct seeding, crop rotation and leaving crop residues on the field.

According to one expert's evidence, the minimal tillage is applied by almost every farmer in Kant, where the Institute's project was implemented several years ago. However, several interviews and field visits suggested that there is only one big progressive agricultural enterprise (former collective farm, but currently privatized by one owner), which applies minimal tillage on one of their fields for growing barley. The rest of farmers in the district use deep traditional tillage technique, and even the agricultural division of local administration have never heard about this practice.

However, several progressive farmers starting to use minimal and zero tillage on their wheat fields, were met in village Stepnoe, and they expressed very positive feedback and intention to apply the method on bigger area in future, in order to become competitive with Russian and Kazakh wheat suppliers. The mentioned big agro-enterprise, based in Kant, is also using zero-tillage, but in the mountainous terrain of Suusamyr valley, where they also have lands, for growing legumes and oil crops. According to "Dongir" machinery supplier (machinery for minimal tillage and direct seeding) based in Bishkek, the majority of farmers, buying their produce, were from Chuy Valley and Batken province, which is on South-West of Kyrgyzstan.

The only component of conservation agriculture, massively applied by Kyrgyz farmers, is crop rotation. As one farmer from Studentcheskoe village expressed it: *"Everybody is doing it [crop rotation], as everybody already understood that it's necessary. For this there is no need of policies anymore, everybody knows it now, and there is no need to prove it anymore to anyone."* There exist many variations of crop sequences rotated. The most popular is rotation of wheat and barley with lucerne (alfalfa), which is a fodder crop and is sown "under cover" of grains and remains on the field for 5 years. For example, big agro-enterprise in Kant alone grows lucerne on around 500 ha. Farmers claim, *"it works for everyone"*. The reasons are: high yields (2 tons per

ha), cheap price of seeds in comparison to European part of former USSR, and obvious soil quality improvement due to nitrogen fixation. Other type is rotation of winter wheat with sugar beet every other year; corn is rotated every 2-3 years. Rotation with legumes is also applied, but less frequently.

Kyrgyz farmers also diversify their crops. They grow small amounts of kidney beans (for instance, 100 ha in Issyk-Ata district). But in the north of Kyrgyzstan in Talas province, this crop is more popular. As one farmer informed, *"people got on their legs, because they get good yields of kidney beans of very good quality, and it is duly valued. People are interested already in this, they are going to the global market, and there are buyers and they are ok with prices"*. Chickpeas are only grown in the South, because they need little water. Sainfoin, which is also a honey crop, is grown in mountainous conditions of Suusamyr valley and At-Bashinsk valley. Safflower – a very essential drought-resistant crop, from which oil and dyes can be produced, disseminated rapidly and spontaneously already in several provinces of Kyrgyzstan (mainly from neighboring Tajikistan and Kazakhstan, where it is cultivated on substantial areas): in Chui, Osh, Uzgen and southern provinces.

A practice, which the Author of this research categorised as climate smart, because it helps considerably save resources such as water, fertilizer, seeds, pesticides and labour; and significantly increases yields, is mulching with plastic film. *"They are using plastic film mulching there, which creates kind of green house, on melons. The vegetation growth is being speed up almost by 1 month, and brings almost 100% seed germination"* (agrarian expert).

It also doesn't require high capital investments (plastic films are cheap). Non-surprisingly, it was positively accepted by farmers in two closely located villages, and the level of its adoption surged only after a couple of years of its first pilot demonstration in the village Stepnoe. *"Then they*

suggested another option – mulching with plastic film, we tried it and now from all the things they recommended, this one is the most working for today, and the area under it increases all the time." (farmer, village Studencheskoe). *"..annual corn, to make it mature even earlier, people mulched it with plastic film, so the corn matures 3-4 weeks earlier, because of heat accumulation under the film, because weeds don't compete with it. It is a new technology, we didn't have it before.."* (farmer, village Stepnoe). *"Everyone applies it here, on melons, on tomatoes, on almost all vegetables"* (farmers, village Stepnoe). Indeed, field visits in these two villages proved high level of application of the technology – plastic sheets were covering every field without exceptions.

However, the information dissemination hasn't overcome the barrier of several kilometers, and hasn't reached the opposite side of the Chui province: even the most innovative farmers in Kant haven't yet even heard about this method. The same was discovered in other provinces of Kyrgyzstan.

One more innovative practice, gladly accepted by farmers, is a new method of more dense seeding of sugar beet with 45 cm of space in between the rows instead of 70 cm. Obviously, it allows to use the land more efficiently, getting higher yields from the same area of land. The reason, why its level of adoption and dissemination is not very high yet, is because it requires purchase of new machinery. *"The cost of new seeders is high, but with new technology the yields are better, because of more dense seeding with these extra 25 cm. I can't say exactly, but about 70-80 rows on 1 ha are added"* (farmer). Nevertheless, several skilled farmers solved the problem by modifying their old machinery and installing new parts they purchased and brought from Osh province: *"Before, we were growing at 70 cm, our machinery was tuned for 70 cm. To make 45 cm, we took off the old wheels, brought narrow wheels from Osh… installed them so*

that now with 45 cm the tractor goes in-between the rows and doesn't smash the plants. Before we had wide wheels (16,5 cm), accommodated for 70 cm space, and these are 9,5 cm" (farmer).

Horticulture is popular in southern provinces of Kyrgyzstan, where farmers grow sweet cherries, apricots, raspberries and even pistachios, which are also cultivated on terraces in Osh province.

And finally, there are an increasing number of private initiatives in organic agriculture, supported by state course. At times, farmers shift to it without acknowledging the method, but simply following successful experiences and advice of their neighbors, for example, using bird droppings and manure as a fertilizer: *"Before they were not even taking manure on the fields, it was lying somewhere.. And in the last years I see that especially in our village, people started to fertilize the fields intensively with manure"* (farmer).

As may be noted, the number of farmers using CSA practices depends, first of all, on the technology and its comparative advantages, but overall remains very limited. The research indicated, that the distribution of CSA in Kyrgyzstan is characterized by a spotted pattern, concentrating around the points where pilot donor-financed projects were implemented. In certain cases (for the most advantageous practices), the dissemination has taken place to the scale of the village and the neighboring villages, for example, mulching with plastic film and growing sainfoin; or even has been widely recognized by farmers across the whole country (crop rotation with lucerne).

However, these numbers are so scares, and the set of adopted (at least to some extent) practices is so limited, suggesting the technological innovation system of CSA in the country is currently positioned in the development phase on the S-curve, describing the process of development, application and diffusion of innovative technologies (Hekkert *et al.* 2011).

A certain number of farmers benefit from the activities of the international and donor organizations, conducting pilot implementations of climate smart agriculture practices in the country. Focus group participants identified the most active implementing partners and donor organisations in Kyrgyzstan, focusing on rural development and climate change adaptation in agriculture: Global Environmental Facility (GEF), International Center for Agricultural Research in Dry Areas (ICARDA), United Nations Development Programme (UNDP), Food and Agriculture Organisation of the United Nations (FAO), World Bank, Helvetas, German Society for International Cooperation (GIZ), Fund "Soros-Kyrgyzstan", US Agency for International Development (USAID), World Food Programme (WFP), Aga Khan Foundation, European Bank for Reconstruction and Development (EBRD), Asian Development Bank (ADB).

Some of these organisations might implement CSA methods, but without direct reference to the CSA concept, for example, World Bank's "Second On-Farm Irrigation Project", "Water Management Improvement Project", "Agricultural Productivity Assistance Project", or projects might target agricultural research (ICARDA), information dissemination (South Korean Program "System of distribution of agricultural information"), education (WFP "State System of courses for farmers through lyceums"), enabling environment (USAID "Agrogorizont") etc., i.e. elements as well important for transition to CSA. And only few projects focus directly on climate smart agriculture, such as regional FAO/GEF project on land degradation and salinization through sustainable land management and climate-smart practices, FAO/GEF project "Sustainable management of mountainous forest and land resources under climate change conditions", FAO/GEF "Central Asian Initiative for Land Management (CACILM 2)", and a project proposal to Green Climate Fund (GCF) by FAO "Transition to Climate Smart Agriculture: mitigation through adaptive and sustainable forest and pasture management under community leadership".

However, these projects in the majority are of small size, involving a few households in a single location. Some experts rather sceptically claim: *"It is unlikely that this is of a mass nature. Several organisations are implementing projects on CSA, but the coverage of farmers is very small. One organisation can cover a maximum of 20-30 farmers. The practical experience disseminates only among them. Non-involved farmers will only observe and it won't go further."* Moreover, few projects are followed by a comprehensive results evaluation and extraction of lessons learnt (expert), and only one project focused on upscaling the CSA activities to a larger area (Southern Agricultural Area Development Project – part of CACILM).

According to the national consulting expert, project activities do not receive any support from the state: *"Something is being done by the international organizations and their NGOs. Government in reality is not interested in this. Yes, they will participate in demonstrations, field days, write reports, report to their superiors and nothing will go beyond this."*

That's why, if the scope of international initiatives is not sufficient, there are even less efforts to implement CSA on national level. The state financing of such national research institutions as Agrarian University of Kyrgyzstan, Institute of Irrigation of Kyrgyzstan and others, has shortened considerably. And although they are making their contribution to implementation of water- and resource-saving agricultural practices in the country, the scope of their activities became very limited after the collapse of the USSR. According to the scientific worker, they are now only using and implementing the old research results, because no new research is being conducted. This is how he describes the process of knowledge dissemination: *"When we are doing investigation, one farmer is being taken as an example, which is used for demonstration in one particular day – called Farmer's day – when farmers gather and watch how it is done. Some are then using it [research results], some think they don't need it"*. Apart from several Farmer days

per year, another way of obtaining information by farmers was described as follows: *"Farmers, who want to get something [knowledge on innovative technology], they come here [research institute] and ask, and who doesn't want – doesn't, no talk. We try to develop small brochures for them, so that they can use it."*

Normally knowledge dissemination should be done by the state extension service. But the Government also doesn't finance such services in Kyrgyzstan. The number of respondents informed that extension agencies existing in the country function on commercial basis, which means they only perform limited number of activities funded by donors' projects, and provide information only on those practices, deemed important by international players. Too often little attention is given to applicability of these practices to the local conditions and context.

The most known among extension services in Kyrgyzstan is RAS (Rural Advisory Service), which has a Center of Education, Consultation and Innovation (CECI). But there are several other smaller extension services agencies, experiencing strong competition for donor's funding. Certainly, this creates wrong stimula and wrong approaches, far away from farmers' interests: *"Everyone who promotes something [a practice], starts to push it, showing only the positive side of the question. Maybe it's the right approach, maybe.. But exactly this approach then kills people's will to deal with this practice"* (farmer). And obviously, in such situation farmers are not able to get information and advice on other climate smart agriculture practices when they need it, also because available extension services are concentrated around the province centers and don't have representations in remote locations.

All these serious reasons – poor access to knowledge; little stimulation by positive examples and experiences; little guidance and no help from extension and state – are not creating favourable conditions for farmers to innovate and experiment.

In majority, farmers in Kyrgyzstan are not willing to experiment. According to the most common opinion, the legacy of the soviet era has significantly influenced their decision-making ability in a negative way: *"USSR in 70 years taught people to be lazy for sure – they were given everything: fertilizer was brought for them, everything.. Now it's hard to change this deeply rooted inside habit"* (expert). Indeed, having in mind strong hands-on approach USSR was using, and strong support to agriculture it was providing with free supplies of water, fertilizer, equipment, seeds and other inputs, it becomes clear why in 30 years it is still so hard for farmers to get used to new order of things and independent decision-making: *"In order to form a new group of people with new mind, time is needed. And we all are made in USSR, and 90% of us waits when Moscow will do for us, decide for us. Ourselves we are a bit inert"* (farmer).

Moreover, frequent cases of full financing of practice implementation by project grants (including purchase of equipment), seldom requiring financial participation by farmer, doesn't stimulate own farmers initiatives too. On the one hand, providing financial incentives is reasonable, because it takes away the risks from farmer, but on the other hand – farmers get used to receiving financial support, which stimulates farmers to wait for new grants instead of investing their own resources in innovations. *"They get used to good quickly, and start waiting when the project will be again"* (expert). It is also natural, that farmers don't value what they get for free, taking it for granted, which often lead to the fact that farmers abandon the practices as soon as the project is over.

Kyrgyz farmers are also considered to be rather lazy by nature, preferring to stay with the old habits and life styles, including the way they used to cultivate soil: *"Our people in general are a bit lazy, they don't really want to do something"* (expert). Again, labour- and knowledge-intensive practices require due maintenance: *"We were working with them, we helped them,*

implemented drip irrigation. Now we can't help them, although they are calling every day. Because when we established already everything, farmer too has to do something himself" (expert).

But certainly, this behavior is more true for small holders, who lack resources and stay cautious to everything new and risky. According to frequently expressed opinions by both experts and farmers, those agricultural producers who have more resources (financial, land, equipment etc.), tend to innovate more readily. *"An interesting phenomenon: people with large incomes are trying to introduce innovative methods – those, who consider farming a profitable business. They invest money in the land, and use a business approach. Today I'll invest this - tomorrow I'll make a profit"* (consulting expert). *"There are farmers who buy [innovative technologies] themselves already, rather rich farmers"* (expert on irrigation). *"We have large farmers, who preserved 2-3 collective farms for themselves, former directors, it's easier for them – they have working green houses, farmers working for them"* (agrarian expert).

Several interesting thoughts were expressed, linking the level of innovativeness and initiativeness in farmers to their ethnical and cultural differences: *"On the South it's a completely different colorit, people there have some influence from the neighboring Tajiks and Uzbeks, they are farmers who better know how to cultivate land, it's different class, they have it for ages"* (expert).

Informants also claim that other nationalities, Chinese for instance, living in the country express more enthusiasm to adopt CSA, than Kyrgyz: *"Chinese know the best what they need, they have maps, they know where water comes from etc. and they make their own calculations and bring their crops. Around Bishkek there are currently a lot of Chinese farms, they have build a lot of green houses, currently they perform experiments on 20, 30 and 60 ha plots, especially on the South".*

There are also other explanations of high level of innovativeness of southern farmers – the necessity to find ways to save resources like water, which is more scarce there: *"On the south the farmers are more active, than here. Because we are supplied with water much better, and on the south they get water through the channel, and everything is calculated there, water is given by time – if you manage to do in time, ok. If not – your problem. They know how to irrigate and how to distribute water"* (expert).

Not only lack of innovativeness among Kyrgyz farmers don't facilitate adoption of CSA practices, but as it was already mentioned, even already adopted practices often get abandoned by farmers. The process was evident already after the USSR collapse. According to an expert, drip irrigation implemented on many big plots of 40-50 ha on the South of Kyrgyzstan was completely abandoned because these plots were separated and distributed among several farmers. The same happened to large horticultural gardens on the land of former collective farms – people were taking out their shares of land and establishing their own, completely different cropping patterns.

Today, a rather common situation is when farmers abandon practices implemented through projects right after the financial incentives are stopped, and go back to their previous activities, which might be considered by them more habitual, or less labour- and knowledge-intensive. For these reason many experts don't consider projects to be useful: *"CSA practices are being implemented on a project basis, i.e. a donor implements the project. The project is over - farmers have returned to their usual methods"* (national expert-consultant). The same opinion was expressed by several farmers, who shared experiences: *"There was a project on biohumus production, people were doing something, the project finished, they dropped it"* (farmer).

Some farmers simply lack education and will to maintain new and knowledge-intensive practices, experts call them *"one-day farmers"*: *"they come, want to get something [adopt the practice]. Then on the second year they abandon it, because they can't manage, like this it [practice] receives anti-promotion."* Obviously, such cases trigger less will to test the practice in other farmers among their neighbors and network. And naturally, if testing phase is absent, no adoption and dissemination of CSA practices can happen.

Function 2. Knowledge development.

The concept of Climate Smart Agriculture was developed in 2010, and since then has received a rapid worldwide acceptance and dissemination. It was widely recognized by experts for its holistic nature and the possibility to address multiple critical issues at the same time, such as food insecurity and climate change. For numerous countries on the globe, becoming more arid and experiencing negative impacts of climate change on agriculture, CSA became of high relevance and extreme importance. Moreover, the concept is so popular because it is a win-win solution, meaning that even in case the climate projections proved wrong, those applying CSA would still benefit from resource saving and income increase. Some 32 countries, including least-developed countries and sub-Saharan African countries, specifically refer to CSA in their Nationally Determined Contributions as a way to achieve obligations made under the Paris Agreement.

The practices and technologies comprising CSA are not only innovations, but also well-known methods, as confirmed by the participants of the workshop, and some of them were used in Central Asia during decades. These include many methods of sustainable agriculture, organic farming, conservation agriculture etc. This forms a solid base of already existing knowledge to build on. Plus, during nine years a collection of successful stories and experiences has been

accumulated, and is being actively promoted by FAO, from whom the concept has originated, and by many other international organisations.

Several UN agencies are working on knowledge base development on climate smart agriculture: Food and Agriculture Organisation of the United Nations (FAO), International Fund for Agricultural Development (IFAD), United Nations Environmental Programme (UNEP), WorldBank (WB), World Food Programme (WFP), including partnering for combining efforts and areas of expertise with others: Consultative Group on International Agricultural Research (CGIAR) and its Research Program on Climate Change, Agriculture and Food Security (CCAFS).

For instance, FAO Economics and Policy Innovations for Climate Smart Agriculture (EPIC) is a programme aimed to conduct in-country research on: assessing the situation (climate impacts on agriculture, vulnerabilities, best livelihood strategies) and understanding the enabling environment (barriers to CSA adoption). However, this programme hasn't targeted Kyrgyzstan yet.

Examples of research on CSA conducted in Kyrgyzstan by international partners are: selection of drought-tolerant varieties of crops and conservation tillage by the International Center for Agricultural Research in the Dry Areas (ICARDA); application of GIS technologies for precision agriculture by Center for Agriculture and Bioscience International (CABI); collaborative research on climate change, agriculture, and food security in Central Asia by International Food Policy Research Institute (IFPRI) etc.

However, because climate smart agriculture practices set is highly specific to local conditions and context, its implementation is a knowledge-intensive process, requiring involvement of national and local research institutions. There 5 research institutions in Kyrgyzstan, which conduct

research of some relevance to climate smart agriculture, they are: Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic; Kyrgyz National Agrarian University named after I.Skryabin; Kyrgyz Research Institute of Agriculture at the Kyrgyz National Agrarian University named after I.Skryabin; Kyrgyz Research Institute of Animal Husbandry, Veterinary Medicine and Pastures at the Kyrgyz National Agrarian University named after Skryabin; The Kyrgyz Scientific Research Institute of Irrigation at the Kyrgyz National Agrarian University named after I.Skryabin.

The expert opinions on the state of national research on CSA in Kyrgyzstan in majority suggest very limited research activity on the topic or full absence of such: *"With all responsibility, I can say that no scientific research on CSA is being carried out. In the 2000s, it was proposed to introduce the sustainable agriculture and climate smart agriculture topics into the programmes of higher education institutions, then to introduce special subjects on the SA/CSA, but nothing moved further than the proposals - the Ministry of Education didn't let this proposal go though"* (expert). However, there is evidence on some investigations ongoing *"on selection of drought-resistant varieties, heat-tolerant breeds of livestock, for example kurduch breed, which develop well in hot conditions"* (expert).

In general, all scientific workers agree on the fact, that the state of research in Kyrgyzstan has significantly deteriorated in comparison to its levels in soviet times: *"Our Institute was established in 1953, it has a long history, we had many professors and academics working here. Before we didn't sit much inside, we were doing research in the field all the time: we were doing complex research, we had biologists, agronoms, hydrotechnics, soil scientists, that's why it was a very strong institute, but one day there comes deterioration"* (expert from Kyrgyz Institute of Irrigation). The financing of agricultural research has been drastically cut down, the number of

scientific researchers decreased multifold, and the actual investigations and experimenting is not being performed. The activities of research institutions are mostly limited to elaborations on the results of previous research.

A representative of the Ministry of Agriculture and Melioration of the Kyrgyz Republic about the local-specific research needed for CSA: *"All we have now is based on the old investigations. Conducting such research for the whole republic is very complicated and very expensive. That's why, if there are pilot projects.. maybe with their funds it is possible to make such location-specific research, but otherwise it's too complicated and too expensive"*.

Additionally to poor state financing, there are no cases of donor funding of national research on CSA in the Kyrgyz Republic yet. One opportunity is a possibility to finance knowledge development on CSA through Green Climate Fund (GCF). Applied research on food systems adaptation to climate change fits into the investment areas of the Fund. Kyrgyzstan is currently implementing GCF Readiness and Preparatory Support Programme, which will enable the country to engage with the Fund and submit relevant project proposals.

There is also a case in Kyrgyzstan, which brings optimism – a businessman-maecenas, who is financing development of horticulture in the country, establishment of drip irrigation systems in fruit gardens and many other climate smart initiatives. He also supports agricultural research and education: *"He is sponsoring things, and he wants to build a chain of professional lyceums, colleges and universities. He already has 3 colleges in Ananyev, Issyk-Kul"* (expert).

Research results obtained by Kyrgyz research institutions is usually published in brochures, scientific journals, university digests, and institution's websites. It is hard to identify, if farmers access this sources in search for information. Mostly they are used by extension services: *"Our developments are all being used by them [Rural Advisory Service], they have consultants, they*

make extracts from scientific research, on the farmer's fields they are consulting them" (agrarian expert). Farmers in Kyrgyzstan seldom have Internet access, and prefer face-to-face communication for obtaining knowledge and information. There is evidence of sporadic initiatives of mostly wealthy farmers and large agroholders, who are interested in innovative technologies, able to decrease costs and increase profits. These farmers visit or call research institutions personally, asking for scientific information and advice. The author of this research herself conducted interviews with several such farmers, whose contacts were provided by the research institutions' scientific workers. And although such cases are not numerous, they still have important role in the dissemination of CSA practices in Kyrgyzstan.

Function 3. *Knowledge dissemination*

Many experts claim, that in Kyrgyzstan *"there is no system of dissemination of knowledge on CSA as such"*.

According to the facts, several international and donor organisations introduce sustainable agricultural practices through project activities, several projects focus on some aspects of climate change adaptation in agriculture (see Table 15). A small share of them is dedicated to climate smart agriculture, mostly run by FAO (Table 15). FAO also hosts a multi-stakeholder platform on Climate-Smart Agriculture (GACSA, http://www.fao.org/gacsa/en/), accepting countries and organizations as members on voluntary basis. It was designed for building partnerships for knowledge dissemination to facilitate transition to CSA in the world.

Table 15. CSA-related projects in the Kyrgyz Republic

Organisation	Project	Activities
FAO, GEF	Integrated natural resources management in drought-prone and	• Multi-country cooperation and partnership for effective complex natural resources management; • Integration of climate resilience into policy, legal and institutional

	salt-affected agricultural production landscapes in Central Asia and Turkey (CACILM 2): Kyrgyzstan – only 180.000$ out of $10 million	mechanisms for complex natural resources management (stimula for CSA); • Knowledge management – regional platform for dissemination of knowledge on SLM and CSA practices; • Upscaling Climate Smart Agriculture practices: Naryn province (Ak-Talin district and Kochkov district), Batken province (Leylek district), Chui province (Panfilov district, Chui district, Suusamyr)
FAO, GCF	Climate smart transformation of land use practices: community driven mitigation via adaptive and sustainable management of forests and pastures	• Mitigation of the impact of climate change and disaster risk reduction through forestry, agroforestry and pasture rehabilitation; • Supporting transition to improved investments in farms to improve productivity, reduce reliance on resources and ensure use of sustainable agricultural practices; • Improving natural resources management at the community, local and national levels
WorldBank	CAMP4ASB: A Regional Platform of Collaboration for Enhanced Resilience	• Rural investments to pilot and learn on climate action: credit lines and technical assistance for climate investments in priority areas; • Climate knowledge services: unified regional analytical platform for climate smart-development in Central Asia, with improved data, knowledge, and decision-support tools; • Strengthening institutions: oversight, coordination, and implementation support at regional and national levels through Regional Steering Committee and Regional & National Coordination Units
WorldBank	Central Asia Water Resources Management Project (CAWaRM)	• Addressing the development of shared and up-to-date data and information platforms (regional and national); • Strengthening the enabling institutional and policy framework for water resources management; • Implementing investments to support improved water resources management
GIZ	The new regional program Sustainable and climate sensitive land use for Economic Development in Central Asia	Land user groups, NGOs and the private sector in Central Asia are promoting the implementation of integrative, climate-sensitive and economically viable land-use approaches: • Elaboration of integrative land management regulations; • Improvement of the conditions for a broad-based implementation of integrative land use approaches; • Strengthening the capacities of actors in terms of integrative land-use forms
WorldBank	Pasture and Livestock Management Improvement Project, 2015-2019	• Generalization of measures and technologies for climate change adaptation by including them in the Pasture committees' work plans; • Establishment and introduction of Early Warning System (EWS);

		• Knowledge management improvement on climate change
WFP – project proposal to GCF	Enhance the capacity of vulnerable communities with low food security through climate services and the diversification of climate-sensitive livelihoods in the Kyrgyz Republic	• Strengthening institutional capacity to obtain climate change-related information; • Diversification of farmers' livelihoods, improving agricultural practices and infrastructure • Knowledge dissemination on climatic risks and climate change adaptation

Several national NGOs are also taking part in these activities, often as a project partner, receiving donor funding: *"We have Semenov association of Kyrgyzstan, a very advanced NGO – they also disseminate knowledge, they work with different donors, conduct seminars"* (expert).

Usually, knowledge is shared directly with several selected farmers-beneficiaries of the project, through introduction of CSA practices on their fields, and educating them on how to use these practices. Later these fields are used as demonstration plots to show successful experience to other famers, which is usually done during Farmers' Days. Information stands and printed information materials can also be used additionally for practice promotion and awareness raising on negative effects of climate change on agriculture. However, the majority of experts consider that these efforts are not sufficient: *"Several NGOs are developing their training and dissemination programmes for SA and CSA. But this is definitely not enough"* (expert).

The system of extension services, which should be responsible for knowledge dissemination, including on CSA, *"does not exist in Kyrgyzstan, as in any country of Central Asia"*. The expert informed, that in Kyrgyz Republic there is no ministry in the government responsible for extension and rural advisory services, and they don't receive state financing. Rural Advisory Service (RAS), the main extension agency in KR, was founded by the World Bank and is financed only from donor sources. The other agencies and training centers also receive funding (and tasks) through projects: *"..they all are supported by some grants of some donor*

organisations, like FAO. Of course, when the financing is stopped, they can not continue their activities" (expert). Although, these agencies are rather numerous *("in every district we have rural advisory services, in every province"* - expert), they are mostly located in province centers, far away from remote rural areas, and their number is still not sufficient to deliver knowledge and information on CSA practices to all the farmers: *"They do work somewhere, but they don't have time for everyone. They are few"* (farmer).

Apart from few farmers projects-beneficiaries, knowledge is disseminated among line ministries officials (mainly those participating in projects), governmental agencies and research institutions through capacity building workshops (Central Asian Climate Smart Agriculture Workshop), through professional trainings and exchange visits – again by the efforts of international organisations. Such events involve very small number of individuals due to resources constraints, and even this institutional memory often get lost in Kyrgyzstan because of high staff turnover (expert). These efforts should be continued by the national institutions to disseminate the received knowledge among the next circle of recipients, but informants claim, this does not happen.

Passive sources of information on CSA practices, potentially available for agricultural stakeholders in Kyrgyzstan, include:

Global open and free databases and best practices knowledge web-platforms, such as WOCAT – the World Overview of Conservation Approaches and Technologies (https://www.wocat.net/en/), FAO-CSA (http://www.fao.org/climate-smart-agriculture/en/), TECA - Technologies and practices for small agricultural producers (http://teca.fao.org/) and KORE - Knowledge Sharing Platform on Resilience (http://www.fao.org/in-action/kore/en/) and others. These knowledge platforms contain general description of technological solutions implemented, context conditions

and sometimes even costs of implementation incurred, but is lacking installation guidelines, schemes and details on the maintenance. Moreover, these websites are not available in Russian/Kyrgyz. Obviously, these sources can only be used by English-speaking national experts, comprising little percent in the Republic. Of course, farmers in their majority are not using them.

There are several local and regional e-platforms with the description of the technologies, which are available in Russian and Kyrgyz languages (Table 16). These sites describe only cases of technologies application, and provide even less details on costs and installation process.

Table 16. Examples of existing e-platforms providing agricultural knowledge and services in Central Asia

Scope	Web-address	Description	Founders/Supporters
KZ	http://www.kazagro.kz/	JSC «Kazagromarketing» national agricultural market information and consulting services.	JSC "National management holding "KazAgro"
KG	http://www.agro-asia.com	Agro-information consulting company	Association of Fruit and Vegetable Enterprises of Kyrgyzstan
TJ	http://www.agroinform.tj	Agricultural Information Marketing System in Tajikistan	Helvetas, ICCO, UNDP, DED, and others
UZ	http://agriculture.uz/	Agricultural Internet resources, information and consulting services	CACAARI, MAWR of Uzbekistan, FAO, Agroweb-UZ, Association of farmers, and others
CA	http://www.cacilm.org/	Central Asian Countries Initiative for Land Management, information repository and knowledge hub	IFAD, ICARDA
CAC	http://www.agrowebcac.org/	Interactive portal for agriculture information and knowledge sharing	FAO
CAC	www.cac-program.org	CGIAR Regional Program for Sustainable Agriculture in CAC	CGIAR, ICARDA

Some information on climate smart practices, such as: drip irrigation models and installation schemes, information on supply options and use of Californian worms, organic farming is available on the website of the Ministry of agriculture, food industry and melioration of

Kyrgyzstan.[1] The Ministry itself has a department of organic farming and a department of adoption of innovative technologies.[2] However, the website does not contain any information on their activities.

Currently there is an initiative on the regional level to create a Central Asian Agricultural Information Forum, where the information on all suitable and promising CSA practices could be found, with a possibility for countries of the region to share experiences and methods, subject to applicability in the other countries of the region, having similar conditions and challenges. According to the workshop participants, it would greatly facilitate the process of knowledge dissemination and advance the research results through avoiding wheel reinvention.

All of these sources are potentially accessible by those farmers, who have computers and Internet access. Currently only 54 % of individuals are using internet in Kyrgyzstan, most of them are urban dwellers (ITU 2013). Moreover, little efforts are made to inform the farmers about the existence of these information sources.

Other sources of knowledge and information on CSA in the country are brochures, digests, journals: *"Our research results are published in our university digest, and this digest is a member of Russian indexes of scientific referencing"* (agronomic expert). One of the most effective methods remains direct demonstration of practices during Farmer's days and through demonstration plots: *"When we are doing investigation, one farmer is being taken as an example, which is used for demonstration in one particular day – called farmer's day – when farmers gather and watch how it is done. Some are then using it, some don't need it"* (national expert). National research institutions also practice knowledge dissemination through direct contacts with

[1] Ministry of Agriculture, Food Industry and Melioration of Kyrgyz Republic. Available at: http://www.agroprod.kg/index.php?aux_page=aux7. Accessed on 28.12.2017
[2] http://www.agroprod.kg/index.php?aux_page=aux16

farmers: *"We go to the field and elaborate on this base some recommendations, trying to help somehow farmers, to meet with them"* (expert on irrigation).

However, such a cumbersome process of knowledge access is definitely constraining the dissemination of knowledge on CSA in the country. Some of the national experts express concern about this situation and the need for new effective solutions: "We have very advanced farmers, and we have farmers who can't even appropriately digest information in Russian. We need a more strategic approach" (expert). Such solution the experts see in the so-called "electronic agriculture" (electronic system of extension), which is a national system, adopted on the national level and managed by the Ministry of Agriculture. *"It can provide enormous information. Call centers is just a small part. For example, a farmer is calling and asking a question. Of course, the person answering might not have a full reply, but he notes down the question, ask for advice and discuss with scientists, if there is a need, and later replies to the farmer in more details. It should be a more complex approach"* (expert). Several informants are sure that "electronic agriculture" has big future in 20-30 years.

Another important "knowledge" issue that might constraint CSA dissemination in Kyrgyzstan is the restricted access to climatic data in the country: *"All information about climatic data is given for a fee, which is quite high. In the Ministry of Agriculture there is a department of emergency situations, but specialists there are nil, that is, they do not understand the significance of climatic data for agriculture. Moreover, they consider this data to be secret"* (expert).

Such an underdeveloped system of agricultural knowledge dissemination (including on CSA) in Kyrgyzstan, obviously creates the conditions where the conventional agricultural practices and old preconceptions persist among farmers. CSA approach for now remains largely unknown in Kyrgyzstan, except by several national specialists working with donor-financed projects

implementing CSA in the country. The focus groups discussions during the high-profile workshop in June 2016 revealed that all the groups of stakeholders, including government officials are unaware about the CSA approach and its benefits, and largely don't understand what it means. Only a number of experts are well informed about sustainable agricultural practices and the emerging climate change impacts experienced by the region.

One of the workshop participants expressed unacceptance of principles of conservation agriculture and adherance to conventional soviet norms of intensive and depleting agricultural practice, like deep tillage and application of huge amounts of pesticides: *"I will tell you how to conserve our agriculture: deep tillage is necessary, because when you till deep, the seeds of other plants and especially of weeds get deep into the soil and can't germinate. And of course our goal should be - chemical treatment, meaning use of herbicides. And the last word is about monoculture - if we thoroughly follow the instructions of growing monocultures, we also contribute to conserving our agriculture"* (workshop participant).

Deep tillage, which was traditionally practiced in soviet times, is still deemed to be a necessary condition of successful agriculture by individuals among all groups of stakeholders: from farmers to government officials. The representative of local administration (agricultural division), when asked about zero- and minimal tillage, expressed not only unawareness and perplexity, but the complete resentment by the very existence of such practice: *"Minimal tillage?… Inefficient tillage you mean?"*. After being explained the concept, the representative replied: *"No-no! We till soil according to the norms. It depends on a crop sown: for grains it's 15 cm, for sugar beet – 25 cm. We have established norms for this. And if we don't do according to the norms, the crop will not grow, it will be defective… and if it is saving moisture or whatever, we haven't heard about it."*

What to say about farmers, the majority of whom are poorly educated, or received education during soviet times. The preconceptions towards "ideologically acceptable" conventional agricultural practices are very strong: *"The majority of farmers, even those who graduated with me, they piously believe that the soil should be deeply tilled. And when I start telling them about minimum tillage, they say: "Abdybek, you must have over-read or something like that"* (agrarian expert).

Many respondents consider that such preconceptions are very hard to eradicate. Nevertheless, they stay optimistic about new generations of farmers: *"Youth appears, who believe and promote through their parents on their fields"* (agrarian expert). As another expert put it: *"New ideas never win. Just the carriers of the old ideas die"*.

Drip irrigation doesn't confront preconceptions, first of all, because it is recognised and promoted centrally: *"Drip irrigation is the most painful topic for us. Well, not painful.. What we need now? Drip irrigation, green houses, all these are perspective and good things"* (agricultural division of the local administration).

However, the system of knowledge dissemination in the country at its current state for sure does not eliminate the lack of knowledge on the technology and it's due exploitation process: *"Mainly furrow irrigation is used in our country. If before we were starting to implement sprinkler irrigators, drip irrigation, subsurface irrigation, impulse irrigation, discrete irrigation, now we don't have this possibility, because people themselves are cutting a branch they sit upon (laughs). Because they percolate holes when they want in trays, brake trays, drive everything into unfunctional condition"* (expert). Such destructive and ignorant behavior can only be explained by farmers' unawareness about the comparative advantages of the method in particular, and about the importance of CSA in the changing climate of Kyrgyzstan in general.

Another big reason, why conventional furrow irrigation retains its popularity with farmers on the main part of the country, is because of the low water charges and abundance of irrigational water. Where water is scarce (on the south), furrow irrigation is already losing its competitiveness.

Function 4. Guidance of the search

The concept of climate smart agriculture was developed by FAO in 2010 and has clearly defined goal and objectives. The goal of CSA is to "effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible" (FAO 2017).

The objectives are rather specific, at the same time they are not as narrow as the principles of conservation agriculture, for example. The CSA objectives leave space for creativity and allow to reflect the local context and conditions in selection of suitable agricultural practices. It has several advantages, which have to facilitate the process of adoption of CSA practices by farmers:

- In order to be considered CSA, the practices have to sustainably increase incomes of agricultural producers. This is a very appealing feature for farmers, who are not willing to adopt a practice if it is not associated with getting profits;
- It can include traditional practices, such a water-saving and land-conserving technologies, existing in the region for a long time. This also facilitates acceptance by farmers since they were/or still using these practices in some locations and thus are familiar with them;
- Because CSA is a set of practices, which is not rigid, the choice can be made taking into account personal preferences of farmers, by including farmers' willingness to adopt and use a CSA practice as one of the selection criteria.

In order to assess the performance of this function, policy analysis of the main legislative, programme and policy documents of the Kyrgyz Republic was conducted. The results of this analysis were considered together (but in priority) with qualitative data, because the knowledge of Kyrgyz citizens of legislative base and policies is very limited (at all levels), especially of the latest developments, not allowing for adequate assessment of the situation.

It was noted that the legislation of the Kyrgyz Republic mainly covers issues of mitigation of climate change, and adaptation is more reflected in national policy documents, both in special national adaptation documents and in sectoral programs.

That's why policy analysis for climate smart agriculture in Kyrgyz Republic covers national development programmes and strategies, adaptation programmes and plans, and sectoral policies (Table 17, Table 18, Table 19).

Table 17. National development programs of the Kyrgyz Republic

Programmes/ Strategies	Date of adoption	Analysis in terms of CSA inclusion
National Sustainable Development Strategy for 2013-2017	Decree of the President of the Kyrgyz Republic of January 21, 2013	The National Sustainable Development Strategy of the Kyrgyz Republic for the period 2013-2017 outlines strategic guidelines for a new model of sustainable development. Chapter 5, sub-chapter 5.1. determines the need to take into account in the strategic planning the issues of adaptation to climate change, including for agriculture, which will bring significant economic benefits to Kyrgyzstan.
Program of transition to sustainable development for 2013-2017	Approved by the Resolution of the Government of the Kyrgyz Republic of April 30, 2013 No. 218	The program recognizes that global climate change is a stable trend. The nature and economy of Kyrgyzstan are very sensitive to these changes. The greatest threat are earthquakes, landslides, mudslides and floods, snow avalanches, other natural phenomena, which together with extreme temperatures can adversely affect the growth and development of crops. Projected also a significant reduction in water resources, up to almost complete (from 64% to 95%) disappearance of glaciers by the year 2100. Over the next twenty years, a steady decline in surface runoff is expected, which may lead to inadequate water availability for agricultire.
The program of the Government of the	Resolution of the Zhogorku Kenesh of	The program is designed for the simultaneous implementation within 5 years of 40 priority steps aimed at improving the quality of life of the

Programmes/ Strategies	Date of adoption	Analysis in terms of CSA inclusion
Kyrgyz Republic "Jany Doorgo - kyrk kadam" for 2018-2022	the Kyrgyz Republic of August 25, 2017 No. 1836-VI	population of KR. Development Program 9. "Environmental Security" CADAM 38: Environmental security and climate adaptation notes that over the past decades climate change and its impacts on the environment, the economy and society have become one of the most pressing global problems of the international community. In this regard, the Government proposes the formation of a long-term vision of national measures to prevent climate change and enhance climate resilience, as well as implement measures to adapt to climate change. The Government is recommended to develop 5 targeted programs in the field of climate change, including: 1) The program on adaptation of water resources will improve the rational use of water resources, introduce economic incentives for rational water use through the expansion of concessional credit mechanisms for water-efficient and water-saving irrigation technologies; 2) The program on agricultural adaptation will focus on the development of organic agriculture and further introduction of agricultural and water-saving technologies, optimization of location and specialization of agricultural production.

Table 18. Adaptation programmes of Kyrgyzstan

Programmes/ Strategies	Date of adoption	Analysis in terms of CSA inclusion
Priorities for adaptation to climate change in the Kyrgyz Republic until 2017	Decree of the Government of the Kyrgyz Republic of October 2, 2013 No. 549	It is the country's main strategic framework document on adaptation to climate change. Among the main objectives are: • Introduction of the practice of rational use of water resources. • Increasing the efficiency of land use and adaptation of agriculture. - optimization of location and specialization of agricultural production; - integrated pasture management and pasture livestock development, taking into account adaptation to climate change. • Studies to assess the level of climate change impacts on wheat productivity and other major crop products, etc.
The program of agriculture and water sectors on adaptation to climate change for the period 2016-2020	Order of the Minister of Agriculture and Land Reclamation of July 31, 2015 No. 228	Sectoral Program on adaptation to climate change of agriculture and water sectors. Provides for adaptation actions in water management, crop and livestock production. To improve the climate resilience of agriculture, the main task is "Improving the efficiency of land use and adaptation of agricultural production technologies". The following measures are proposed: • Creation and adoption of new drought tolerant varieties and crops adapted to local conditions; • Soil-protective technologies, minimization of technogenic impact on soil; • Rational use of irrigation water (sprinkling, drip irrigation, etc.);

Programmes/ Strategies	Date of adoption	Analysis in terms of CSA inclusion
		• Optimum crop rotations; • Wide application of organo-mineral fertilizers, mulching, use of compost, etc.; • Application of innovative technologies of crop cultivation (organic farming, introduction of ecological resource-saving technologies of cultivation, meliorative improvements, etc.); • Application of innovative measures to combat erosion and salinization of soils; • Creation of shelter belts in arid regions, which will increase the moisture reserve in the soil and weaken the influence of dry winds; • Shift of spring sowing dates for earlier crops, and winter crops for later periods for better use of moisture resources; • Organization of consultations and trainings for stakeholders on vulnerability and management of climate risks in crop production; • Adopt institutional and regulatory measures, such as the introduction of an early warning system in crop production and other forecasting and preparedness systems for crisis situations. • Development of breeding strategies by strengthening local breeds adapted to local climatic stresses and sources of feed, and improving local breeds by crossing with breeds that are more toleratant to heat and less prone to diseases; • Development of methods for assessing damage and insurancing livestock sector. • Compliance with rational pasture use systems. • Rational use of water resources - reduction of water losses in irrigation systems, application of advanced irrigation technologies, drip irrigation. In addition, at the beginning of the document, the concept of CSA is directly mentioned: *"We must take preventive measures that mitigate the impact of global climate change on agricultural production and food security. The climate smart agriculture model includes three main objectives:* *- sustainable increase in the productivity of agriculture and income;* *- helping farmers adapt and become more resilient to the effects of climate change;* *- reduction or elimination of greenhouse gas emissions from agricultural activities. "* Also mentioned the need to use such CSA practices as: *"organic farming, soil erosion control, mulching, cultivation of cover crops, integrated management of nutrients (including the use of manure and compost), agroforestry and more effective management of rangelands. Thanks to more efficient management of nutrients, it is possible to reduce emissions of nitric oxide, while contributing to the absorption of carbon by soil. "*

Table 19. Sectoral and territorial development programmes of the Kyrgyz Republic

Programmes/ Strategies	Date of adoption	Analysis in terms of CSA inclusion
The Concept of Preservation and Improvement of Soil Fertility of Agricultural Land in the Kyrgyz Republic for 2017-2020 and the Action Plan for its Implementation	Resolution of the Government of the Kyrgyz Republic No. 414 of June 30, 2017	It was designed to strengthen food security, reduce poverty and create a safe ecological environment and aimed to identify the main directions of the national policy of sustainable land management. The main goal is the systematic reproduction of soil fertility of agricultural lands, improving the balance of nutrients in soils, taking into account the bioclimatic potential of agro landscapes and obtaining stable yields. It includes the following tasks: - protection and conservation of agricultural land from water and wind erosion and desertification; - decreasing the degree of soil salinity; - preservation and maintenance of agrolandscapes in the agricultural production system; - development of scientific methodologies, recommendations and technologies for soil conservation and improvement of soil fertility of agricultural lands.

Although directly referring to the CSA concept in the beginning of the document, and expressing the need for the implementation of several CSA practices and technologies, sectoral agricultural programme for climate change adaptation in KR doesn't articulate the ways for achieving its objectives, and fail to show the actual pathway for transition to CSA.

The policy analysis suggested also that more specific policies and strategies and detailed action plans are absent, many documents are outdated and the new ones were not developed and/or adopted. According to the informant, several draft policies, developed with the help of international partners, were not adopted by the Government of the Kyrgyz Republic: *"In the period from 2010 to 2015 me and my colleagues in the UNDP project have developed the drafts of the State Program for the Conservation and Improvement of Soil Fertility, the Program for Improving the Meliorative State of Irrigated Lands, the Integrated Programme for Sustainable Land Management. None of them was adopted by the Government due to the lack of money"* (expert).

Not only the weak guidance in the direction of CSA from the central government doesn't facilitate transition to CSA in Kyrgyzstan, but certain old legislation and policies are constraining adoption of several climate smart practices.

An international expert working in Kyrgyzstan informed that Kyrgyz legislation does not allow agroforestry: it prohibits to grow crops on forest land and trees on agricultural land. He brought an example, when a farmer was trying to lobby the possibility to get permission to plant trees on his field as protection belts, by proving protection purposes, but still didn't get any result. Indeed, according to the Kyrgyz Forest Code, all forest land (including all orchard trees on leshoz land) belongs to state property. The farmers can only lease the forest lands run by leshozes, receiving the right to collect non-timber forest fruit and obligation to contribute to afforestation and forest protection in return.

However, several sources suggest that there exist cases when farmers grow maize, sunflowers, potatoes and vegetables in the inter-row space of the orchards, and even use this space for livestock grazing. It was discovered that a number of leshozes gave permission to farmers not only to collect nuts and fruits from the orchards, but also to use the inter-row space for hay making, grazing and arable cropping, at times these rights are even outlined in the leasing agreements. Moreover, there is an increased evidence of farmers leasing the lands of former sovkhozes, which can be privately owned. These farmers experiment more by growing more species (poplar, damson tree together with apple; pear or rose-hip, peach and apple; pear and cherry together with walnut), as well as using inter-row space for growing berries or tree seedlings.

In this situation it is obvious, that if the abovementioned point in the Forest Code of the Kyrgyz Republic were amended, it would trigger the rapid development of agroforestry and integrated forest-crop-livestock systems in the country.

The similar legislation is constraining sustainable pasture management. According to the Kyrgyz law, pastures in Kyrgyzstan are not private, the pasture land belongs to the state. Farmers are not interested in conserving state-owned land, trying to receive as much from it as they can. Because of this, and due to absence of efficient state policies for rangeland management, pastures became overgrazed and largely deteriorated since the breakdown of the USSR.

Not only the majority of national informants, but surprisingly even one international FAO expert, unanimously agreed that a hands-on approach from the government is needed in the country for upscaling CSA, similar to that, which existed in the former USSR, or is currently present in the neighboring Uzbekistan. *"Before it was better (laughs). Strict regulations, as they were in the soviet times, are needed"* (international expert).

Apart from outdated legislation acting as disincentive or even barrier to CSA adoption, old agricultural norms also constrain dissemination of minimal and zero-tillage, for instance. One local administration informed, that in their district the land is tilled at 15-25 cm depending on the crop, in strict accordance to the norms.

Few cases of CSA-favourable policies are, nevertheless, present in the Kyrgyz Republic. The Action Plan of the Kyrgyz Government from 2015 "to strengthen the national economy" among measures for strengthening agriculture contains such actions as development of advanced irrigation systems in all regions of the country. However, the document doesn't contain detailed information on the intended locations of the drip irrigation systems and funding allocated, and should be considered more as directions for future, than a real action plan. According to a

national expert, the latest efforts of the Kyrgyz Government in this area include also creating conditions for crediting farmers to buy the equipment for drip irrigation. Also on the Order of the Ministry of Agriculture and Land Reclamation № 50 from 02.24.2015 the "Center for introduction of innovative advanced resource-saving technologies in agriculture" was established.

As for the other state policies that might be beneficial for CSA adoption and dissemination, there is evidence of indirect support of agricultural producers of certain crops – by putting obligation on foreign processing and production factories to buy the produce from all farmers, who wish to sell it, through fixed-price contracts, even if the actual supplied volume is exceeding the needed quantity: *"Very many farmers who made contracts with this factory.. And they [factory] can't refuse, the government asks – not asks, but voluntarily-forced: whoever wants, don't refuse. Last year a lot of beetroot was delivered, so they had to accept it at their own loss, a lot of beetroot was rotten, they didn't manage to process"* (farmer). Such policy undoubtedly creates favourable conditions for farmers to diversify their cropping patterns, increasing production of vegetables and fruits.

It is clear that a very small number of CSA-friendly policies (mentioned above) are insufficient for making transition to CSA happen. Informants unanimously blame the indifferent position of the central government: *"In our country the policy of the state is like this: guys, you don't touch me, I won't touch you. Live the way you want, come to election and vote for me. And good buy. In the rest of time you forget about me, I forget about you"* (farmer).

Interesting remarks were made by one farmer, who proposed his own policy solutions for CSA promotion: *"..cooperate, buy together this seeder. And if you cooperate, we'll give the credit with this low rate – state policy should be like this. If you do together a common rotation – lets say, this year you sow tomatoes, next year – wheat, etc… Or you sow together on this area tomatoes,*

where 20 sotok are owned by one farmer, 20 sotok – by another etc. And if you do it like this together, we will give you this and that – state should be doing like this" (farmer). Economic incentives, suggested by this farmer, sound reasonable and might be an effective mechanism to encourage cooperation and adoption of climate smart technologies. As well as a participatory research (especially with participation of farmers) could be an effective approach for state policy design in Kyrgyzstan.

Function 5. Market formation

The market for CSA inputs, e.g. machinery (direct seeders, drip irrigation equipment etc.), seeds (heat-, drought-tolerant varieties, alternative crops etc.), organic fertilizers, is developing in Kyrgyzstan.

Respondents informed, that there is a big number of countries-importers of agricultural machinery to Kyrgyzstan, the main among them are China and Turkey (cultivators, pipes), Russia (e.g. RosSegMash), Germany, Belarus, Holland (combine-harvesters) and others. In general, own machinery production is not developing: *"We have calculated that it is not feasible for us to establish our own factories, because we are not being supported in it. It is more economically feasible to buy technologies – starting from Israel to the USA – all offer its produce"* (expert).

Drip irrigation equipment, used in Kyrgyzstan, is being produced in India and Nepal, and has below average quality: *"..currently being installed primitive systems: Indian systems, Nepali systems, install and then change in 5 years"* (expert). The better quality technologies (also more expensive) are brought from Russia, Hungary and Poland. However, the irrigation expert informed that the production of hoses, nozzles and pipes for drip irrigation has been recently started in Bishkek, and this produce, therefore, is much cheaper.

The minimal tillage machinery is supplied by Germany. Turkey actively imports in Kyrgyzstan point seeders for direct seeding, together with many other kinds of equipment: *"Any machinery now comes in from Turkey. If you don't have here, you order and in 7-10 days this machinery arrives"* (farmer). There are also several companies-distributors of agricultural machinery in the country, for example, "Atalyk" in Kant (official dealer of Russian "RosSegMash") and "Eurasia Group" in Bishkek - distributes innovative machinery, including American "Dongir" machinery for minimal tillage.

As for the seeds market, experts informed, that during soviet times Kyrgyzstan was a seed supplier of seeds of sugar beat and alfalfa, supplying with them markets in Russia, Belarus and Baltic counties. Currently the Republic remains self-sufficient in terms of seeds of the main crops, and farmers have a stable supply of them, especially of corn, grain crops, sugar beat – on 100%. However, high quality seeds, complying with international standards are only registered through one lab in the country, which passed 4th accreditation of ISTA (International Seed Testing Association). According to an expert, farmers often use their own seeds, not complying with standards: polluted, of low yielding quality.

High quality seeds of winter wheat with 100% germination are imported from Germany: *"..they are strong, but also very expensive – 8.800 Soms per kilo of seeds. While Russian seeds are something like 7.000 per kilo"* (farmer). Buying German seeds makes sense for farmers using direct point seeders, due to high germination and low consumption of seeds (just 1 kg per 1 ha). Seeds of drought-resistant crops like safflower, are imported from neighboring Kazakhstan and Tajikistan, or from Russia – usually by large agro enterprises, which further sell the seeds to the farmers (Ltd."Atalyk").

The sources of organic fertilizers (manure and bird droppings) are either own production (for those farmers who have several heads of livestock additionally to crop production), or larger livestock/bird producers: *"Bird farmers always have the will to get rid of the bird droppings"* (farmer).

Experts, nevertheless, tend to think that input markets are insufficient in the country: *"A number of domestic and foreign companies are working in Kyrgyzstan to supply the country with agricultural machinery, fertilizer and seeds. However, this is not enough. There is a large deficit of good quality machinery"* (expert).

The output markets for CSA produce are at times different (organic products), but most often are the same markets as those where conventional produce is sold. They are as well important for the upscaling of CSA, as input markets, because without being able to sell their produce and make profit, farmers won't have the needed resources for further conducting agricultural activities, including CSA. Subsistence agriculture, signifying agricultural production for own consumption only, is vulnerable to climate risks. Therefore, developing output markets is crucial for increasing farmers' resilience to climate change.

Output markets development in Kyrgyzstan much depends on the crop type. For certain alternative crops, such as kidney beans, there is a rather developed external market – Turkey is the main buyer of this produce: *"Turkish, they need kidney beans, they come and make contracts, and irrespective of what price will be in autumn, they pay partially in advance at a fixed price. So may Turkish loose, may farmers loose. Then they come in autumn, and take their produce...They started to sell for 120 Soms (approximately 2$ per kilo), now it's 1-1,5$. This price is also good, if the yields are good they get good profit"* (expert).

At the same time, the inner market for kidney beans, as well as for other pulses is almost nonexistent. The reason is that Kyrgyz don't have an eating habit for beans, so their consumption level inside the country is near zero percent. One interviewee from Turkey considers this to be the biggest problem of the Kyrgyz agriculture: *"You have to eat 50%, and 50 % - to sell, then you will have profit.. And like this, you sell 100%, and at the same time, you depend on someone, on [external] market, and don't use what you have."*

There is also a good market for sugar beet: foreign factories-processors (Russian and German) of sugar beet in the country make contracts with farmers with a fixed in advance price for their produce, and prepay its production with seeds, cash or in other ways. *"The fixed price is 3,40 Soms for 1 kilo. We are ok with this, because they not only came and bought the factory, they brought their technologies to us"* (farmer). This is also being supported by the government, who oblige foreign factories to buy all the produce from all those farmers who wish to sell it. The farmers interviewed feel more secure having this option: *"Of course, it's good. I can be sure, that I'll sell my produce"* (farmer). Probably this has led to the fact that in the last years the sugar beet production in Kyrgyzstan increased 13 times from 54.000 tonnes in 2008 to 705.183 tonnes in 2016 (WorldBank 2018).

Similarly, direct supply contracts are made with farmers for tomatoes, cucumbers, melons and some other vegetables and fruits. *"Now on the South they started to grow sweet cherries. Russia comes in advance and gives money in advance, so that they don't sell to anyone else. They have refrigerators, they bring boxes, and pick cherries up themselves and sort, from 1 ha they get 1 mln Soms. On the south on the Issyk-Kul they started to grow apricots – royal, big and very tasty. Russia buys them regardless of customs and expenses, they go and order in advance"* (expert). *"For tomatoes we now have good processors, we make contracts with them on direct supply. And*

they are taking all our produce. In this sense [it is good]. Cucumbers the same, processor take, in this sense it turns out to be good. Paprika is more exported…mostly to Russia" (farmer 1). "*Melons, watermelons – nowadays Chuy valley is becoming slowly the supplier for the whole Kyrgyzstan. It's grown with plastic film mulching. The yields and quality we get is good*" (farmer 2).

According to an expert, Kyrgyzstan is self-sufficient on 130% in terms of potatoes, and has the 1t place in Central Asia on potato production. On fruit and vegetables production it stands on the forefront positions with major export markets in Kazakhstan and Russia.

More difficult situation is with grains – no pre-orders or permanent buyers exist in Kyrgyzstan. *"The problem is that farmers can't realize their agricultural produce. There is no such state approach, so that they could buy from people and re-sell and work on realization in-between the states"* (expert). In addition, wheat, which is imported from Russia and Kazakhstan, appears to be cheaper and this creates negative incentives for producers. On the other hand, application of such CSA practices as minimal tillage or zero-tillage gives a lot of advantages for farmers in terms of decreased costs, labour and time, that this makes them competitive with Russian and Kazakh wheat importers.

Certain difficulties with the sales of fast-spoiling produce, experienced by the Kyrgyz farmers, could be overcome with development of due processing and storage. However, currently mostly only the factories have storage and processing facilities. For farmers it appears unprofitable taking into account little volumes of produce, the high costs of the equipment, and a high risk of pests' development during storage. *"..then pests appear on it [soya] - bean weevil, soya weevil, just a bit warm conditions and they appear and destroy the harvest"* (expert). However, a number of farmers who strategically purchased processing equipment, receive good returns on it:

"..those who started from processing, they have consumers. They buy agricultural produce from farmers, process themselves, and provide to the consumer... They occupied the niche, and because of this they are holding" (farmer).

Apart from selling their produce on local markets ("bazars"), to national and international processors, a number of farmers also apply strategies for selling their produce at higher cost: *"..in order to make profit, they will take the harvest and sell it on Isyk-Kul, where there is already a start of the season, for a very high price, and they will get good profits.."* (farmer).

There is a number of agroholding innovative companies in the country (e.g. Ltd. "Atalyk"), who create favourable conditions for farmers by ensuring both input and output markets and facilitate dissemination of CSA among them. In particular, for a number of crops, including grains, oil crops, etc. they provide farmers with supplier credit for seeds, machinery, sign interlinked contracts at a fixed guaranteed price. They even educate farmers on the use of CSA practices (minimal tillage, direct seeding), on growing seeds (safflower). They usually have processing factories in property, so provide a large output market for barley (beer factory), grapes (champagne factory and wine factory), safflower and rape (oil factories) and wheat (Ltd. "Atalyk" is state supplier of wheat).

Overall, there is an apparent need for development of existing and creation of new output markets for certain types of produce like pulses (inner markets) and for alternative crops (outside markets). Farmers also express the will to broaden the interlinked contracting and extend it to the rest of the crops in order to create the complex value chains: *"We have problems with the realization of the produce. Sometimes overproduction happens, like of onions, and they have to through away into waste pits, because they cant get rid of it [sell]. Sometimes there is*

overproduction of potatoes, sometimes – shortage. There is no in advance contracting. If we only had it.." (farmer).

However, currently the country faces certain barriers for market development. For example, a number of standards on the international market constrain exports of Kyrgyz agricultural produce outside Kyrgyzstan. Meanwhile, the high quality of the produce often complying with these international standards, clearly determines the need for creation of laboratories and development of certification procedures.

The recent accession of Kyrgyzstan to the Eurasian Economic Union (EAEU) creates stronger competitive environment in the economic area, first of all, from producers from Russia, Belorussia and Kazakhstan with more competitive experience in the agricultural sector. *"We also export, but they don't allow us with competition, we are small.."* (expert). However, membership in EAEU also means the reduction of trade barriers for export of farmers' produce and facilitated imports of agricultural machinery, equipment, and other CSA inputs from the EAEU member countries, which creates favorable conditions for CSA development.

In certain cases, competition with other countries for output markets, for instance, with Kazakhstan and Russia, who import in Kyrgyzstan cheap grains, acts as an incentive to adopt zero- and minimal tillage to decrease the production costs and maintain competitive prices for Kyrgyz grain produce. *"Everything now depends on the price of the grain. Meaning, Kazakhstan is close, Russia is close, as if we are all living in one house. From there they bring grain with minimal costs, very cheap. You see, when they bring, it's not profitable for us to sell with our net costs. And if so, there is no reason for us to cultivate it. But with the new technology [minimal tillage] already we can win something and get profit. So in the future we will shift to the new technology in order to compete with them"* (farmer).

Function 6. Resources mobilization

In general, there are low availability of financial resources and level of investment in the agricultural sector in Kyrgyzstan. Even less (a small share) is used for adoption and dissemination of CSA in the country. The available financial resources can be classified as follows:

- International (international organisations and donors)
- Public (public expenditures on agriculture, state-owned banks)
- Private (farmers, agro-enterprises, financial cooperatives, private banks, financial and microfinance institutions)

Financial resources of the Kyrgyz farmers are scarce, the majority of them are smallholders and family farmers with 1-2 ha plots. There are also a number of agro-enterprises and agroholdings, usually former collective farms privatized by a single owner, which have bigger working capital, land, machinery and resources. Some of these agroholdings (Ltd. "Atalyk", for instance) credit farmers with seeds or sell machinery in leasing.

International funding of the CSA implementation in Kyrgyzstan is limited, having point pattern (concentrated in the locations of projects activities, which mostly cover the area from one farm to one village) and in the majority of cases is of short duration. Moreover, these financial resources are mostly focused on the adoption of the practice, and don't consider its further dissemination and upscaling. Even the larger scale project like "Integrated natural resources management in drought-prone and salt-affected agricultural production landscapes in Central Asia and Turkey" (CACILM 2) with the overall financing of $10 million, disburse only 180.000$ for Kyrgyzstan (one of 6 countries-beneficiaries).

A potential opportunity for Kyrgyzstan is financing CSA projects with financial help of the Green Climate Fund (GCF). GCF is financing transformational projects in climate change mitigation and adaptation, and has food security among its result areas. KR is working with GCF since 2016 through GCF Readiness Programme, and has already put agriculture among its priority areas for GCF investments. However, international financing volumes and piloting initiatives are not sufficient for country-scale transition to CSA and should be supported by public funding.

Nevertheless, national experts inform, *"there is no Government funding for the dissemination of the sustainable agriculture and CSA in Kyrgyzstan"*. Moreover, according to the official estimates, the State support for agricultural producers in Kyrgyzstan was equal to 2.5% of the value of agricultural production of the country in 2015 (MALR *et al.* 2015), which is *"inadequately low, even taking into account the limited capacity of the State budget of the Kyrgyz Republic"*.

The only measure of State support in Kyrgyzstan is the credit for the development of the agricultural sector with preferential interest rates for the period of up to 36 months, provided in the frame of the State project "Financing of agriculture" (FA). The project has already 6 phases. In FA 1-4, the interest rate was 10%, and livestock accounted for about 80% of all loans provided. Starting from the project Financing Agriculture-5 (FA-5), credits for farmers are given at 10% for crop and livestock production, 8% for horticulture and 6% for processing of agricultural products and export activities. The decision to lower the interest rate was taken primarily to ensure full output of agricultural products for export and support to farmers: *"At present, the government sets a task to increase the volume of agricultural products with a high share of processing, as well as export development"* (Ministry of Finance of KR).

In February 2018 the Government of the Kyrgyz Republic approved the project "Financing of Agriculture-6" for 2018-2020. The amount of the project is 1 billion 50 million Soms. Cattle breeders will be able to get loans at 10% per annum, plant growers - at 8%, processors of agricultural products - at 6%. Half of the amount of funding will be given to the livestock sector. The remaining two industries will receive approximately 250 million Soms.

According to the Ministry of Finance, from 2013 to the present, preferential loans were issued to almost 53.6 thousand entities for the amount of 17.1 billion Soms. Together with the National Bank, commercial banks involved in the project, are: "Aiyl Bank", "RSK Bank", "KIBK", "CB KYRGYZSTAN", and "Bakay Bank".

However, the number of state subsidized preferential credits is limited and available to a very small number of farmers. *"..they are not enough - only about 20% of farmers, or even less are credited" (expert); "10% credit is hard to get, not because they [state] don't want to give – they give, but also impossible to give to everyone, the country is not rich"* (farmer). Secondly, even preferential interest rate is considered to be too high by both experts and farmers to be economically viable for agriculture: *"I think interest rates are very high. 10% rate for agriculture is very high"* (expert); *"In agriculture it's not feasible to take credits with such percent"* (farmer). Moreover, even this type of credit does not distinct between conventional and innovative practices, the same as between depleting and resource-saving practices. Therefore, it can't be considered as a favourable source of finance for CSA dissemination.

In general, according to expert opinions, *"the system of crediting and microcredits for agriculture in Kyrgyzstan is poorly developed"* (expert). The rest of possibilities include obtaining credits from commercial banks under 12-34% interest rate (Table 20), which is fairly considered "predatory" by farmers, not having large returns on their activities and facing high

inflation and devaluation of currency. Such conditions in most cases discourage them from relying on credits: "*..all these talks about credit, percent rates – they are for politicians. In agriculture, any crop that you grow – apart from opium popper – has only one harvest per year, which in best case gives you 40-45 % of profit. And now imagine: a family of 3-5 members, having 5 ha of land, if the land is the main source of income, they invest 10.000$, they get 4.500$ of net profit. This family meanwhile spends on basic stuff 2000-2500$ per year. The rest is about 2000$. Inflation reduces it by some part, plus devaluation of currency. The majority of things that come for agriculture are counted in USD, but we earn in Soms – here we lose a lot. It means that the value of money at the moment when I earn them is 20-22% less then at the moment when I was investing. I am running like a squirrel in the wheel. In this situation even 10% of interest rate for credit is a lot"* (farmer).

Table 20. Types of credits for agriculture provided by banks in Kyrgyzstan on June 2018

Name of credit	Bank	Interest rate, %	Amount, Soms	Period, months	Sub-sectors	Collateral
Agro-credit	Bai-Tushum Bank	15	from 10.000	up to 24	crop and livestock production	real estate, mixed
Agro-credit	Kyrgyz Investment Bank	16-20	from 35.000	up to 60	crop, livestock, processing	real estate, movable property
Kumtor-chakan	Aiyl Bank	10	from 5.000	up to 12	crop, livestock, processing	no
Agro-credit	RSK Bank	20	from 50.000	up to 36	crop and livestock production	real estate
Crop Production	Aiyl Bank	10-23	from 50.000	up to 120	crop production, horticulture, forestry	real estate and movable property
Mal-charba-nasyjasy	Aiyl Bank	10-23	from 50.000	up to 84	livestock production	real estate and movable property
Agro	FinanceCreditBank KAB	no info	up to 1.000.000	up to 36	crop and livestock production	no info

Sweet Harvest	Bay-Tushum Bank	12	from 10.000	up to 12	growing sugar beet	signed contract with Ltd "Kaindy-Kant"
Sugar Beet	Commercial Bank Kyrgyzstan	12,4	from 30.000	up to 10	growing sugar beet	signed contract with Ltd "Kaindy-Kant"
Farmers' support	Bay-Tushum Bank	12	from 10.000	up to 12	crop and livestock production	contract with one of partner factories
Investment credits for agriculture	Commercial Bank Kyrgyzstan	12,4 – 17,4	up to 35.000.000	up to 36	agro-production, machinery purchase, processing	all
Agro credit "Trust" (no-collateral)	Commercial Bank Kyrgyzstan	32-34	from 2.000	up to 24	all	no
Agro credit "Trust" (secured by movable property)	Commercial Bank Kyrgyzstan	25-30	from 2.000	up to 36	all agriculture	all types
Agro credit "Development"	Commercial Bank Kyrgyzstan	20-27	from 2.000	up to 60	all	real estate (obl.), others
Agro credit	Optima Bank	from 14	from 3.500	up to 60	all	no info
Agro	Finca Bank	no info	up to 2.000.000	up to 60	all	all types

Source of data: Akchabar. Financial Portal 2018

However, national financial statistics informs, that there has been a substantial increase in the amount of credit provided by banks that is directed to the agricultural sector (Figure 17). While in 2008 commercial banks provided 2312 million Soms to farmers, this increased to 24663 million Soms in 2016 (NationalBank 2018), or by 967 percent. Obviously, the policy of state subsidizing agricultural loans has had its effect.

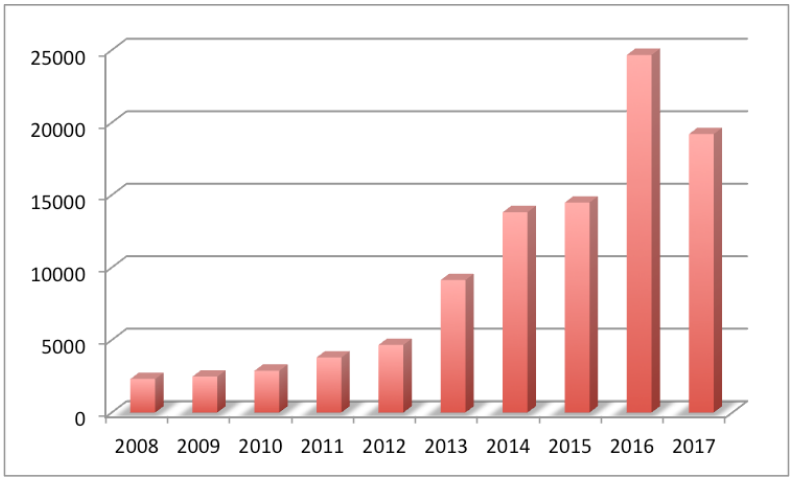


Figure 17. Loans extended to agriculture by commercial banks in Kyrgyzstan, by years

Source of data: National Statistical Committee of the Kyrgyz Republic 2018

There was also an increase in credit provided by non-bank financial institutions (Figure 18), it grew from 348 million Soms in 2004 to 8550 million Soms in 2014 (NationalBank 2018), or by 2357 percent. The decrease in the last three years is explained by the conversion of several microfinance institutions into banks.

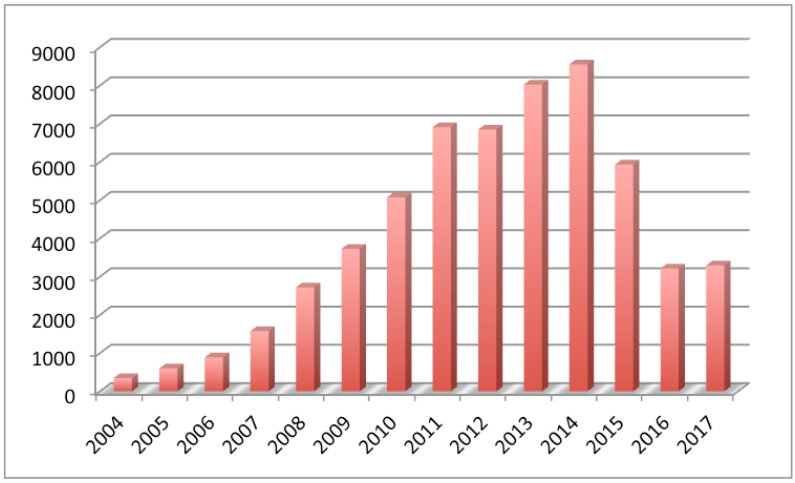


Figure 18. Loans extended to agriculture by non-bank finance and credit organizations in Kyrgyzstan, by years

Source of data: National Statistical Committee of the Kyrgyz Republic 2018

The interest rates of microcredits are higher: from 18% and up to 59 %, on average - 39 % (expert).

There are also other sources of credit available for Kyrgyz farmers: supplier credit and short-term financing through interlinked contracts with processing factories (see function 5). A popular option in Kyrgyzstan is taking machinery in leasing which is possible under 6% interest – this could facilitate dissemination of such CSA practices, as direct seeding and minimal tillage, drip irrigation and others requiring use of special equipment.

In many cases the credits are taken by medium-income farmers who have savings to secure their position and decrease the risks: *"Why I take, because I am finishing one thing and don't have enough. At least I know, that even if I don't have big profit, I have extra money to return the credit. And in other case to take such risk [is not worth it]… There are some who took risk, and now they don't have neither job, nor money. You should be very careful here. Banks do not forgive"* (farmer).

According to the information provided by one farmer, the Islamic Development Bank is providing risk-free credits for farmers for proved agricultural activities with amounts of up to 100.000$ and with 0% rate. *"They work 50/50, meaning 50% of profit is given to the bank. Even if there's no profit, the farmer keeps working on the project. And if truly, it didn't work out and there's no profit, they don't ask it back. But if everything goes well, giving 50% of profit is a lot. But there are no risks, it's guaranteed that you won't appear in bad situation"* (farmer). For many poor farmers in Kyrgyzstan such risk-free option is appealing and might be suitable to make initial investments in CSA.

A good mechanism for decreasing climate risks in agriculture – climate crop insurance – is almost non-existent in Kyrgyzstan: *"There is no such thing. The insurance criteria have not been developed. Insurance companies do not want to do this. The weather is too complicated for us"* (expert).

In reality, the Kyrgyz government has made several attempts to increase the use of agricultural insurance in the country. The law "on the peculiarities of insurancing in crop production" (Kyrgyzstan 2009b) was adopted in 2009. It set up a voluntary area-based crop insurance scheme to insure crop losses as a result of weather hazards, under which 50% of the cost of insurance premiums is subsidized from the state budget. Insurance companies have to transfer 5% of received crop insurance premiums to a Kyrgyz Agriculture Insurance Fund (Kyrgyzstan 2009b). The law was poorly accepted by the insurance industry – only few insurance companies offer it and even fewer farmers buy it. According to an expert, in total 17 private insurance companies operate in Kyrgyzstan, from them only 5 have license to provide crop insurance, 3 have license for both livestock and crop insurance, and only one of these companies is actually providing agricultural insurance - to one client (a poultry farmer).

In 2011 the Ministry of Agriculture drafted a law on livestock insurance, but this law still has not been passed.

In cases of major weather hazards, which destroy vast agricultural crop yields, the state takes on the role of supporter, providing farmers with free seeds, fertilizers etc. *"..there is state insurancing, like emergency service – they come, estimate, this farmers has lost this part of harvest, lets compensate him in this way. They give him seeds, fertilizers for next year. State takes on this role – but this is in case of large emergencies. But there is no incorporated whole service"* (expert). For instance, according to Agriculture and Water Management Adaptation to Climate Change Programme for 2016–2020 of Kyrgyz Republic, for the purposes of state support to livestock farmers in the districts, which suffered from heavy snowfalls, 3,5 million Soms were allocated from the state budget for transporting mixed fodder and hay into the damaged areas, 1

thousand tonnes of barley was bought and distributed among farmers for the total sum of 12 million Soms (MALR 2016).

However, national experts consider climate insurancing of agricultural yields has a future in the country: *"There are good prospects. I have developed a number of insurance criteria that have been submitted to some companies, waiting for a reply"* (expert).

Function 7. Creation of legitimacy

Face-to-face discussions with farmers revealed, that the majority of them tend to avoid large investments in agriculture in general, considering the returns to be not sufficient enough to justify it: *"Agriculture is a rather complicated thing, and it requires additional investments. In "pure" agriculture with the high percentage of manual labour it is impossible to get profits. And high mechanisation to substitute for manual labour, with our starting capital is impossible"* (farmer). The most common reason for not investing in agricultural machinery, including for CSA, mentioned by farmers, was the very small size of farming plots, which makes purchase of expensive equipment economically unreasonable: *"With this reforming of agriculture, they have fragmented farms to such an extent, that any machinery doesn't pay off. So if you provide machinery like a service, in this case it might work. But in parallel growing crops, and using this machinery is very complicated"* (farmer). Indeed, drip irrigation systems, for example, is possible to establish on small plots of 1-2 ha, typical size of farms in the Kyrgyz Republic. However, according to the expert's estimates, the smallest size of the plot, on which installation of drip irrigation system would be economically feasible, is 10 ha.

Instead, Kyrgyz farmers try to choose the options requiring minimal investments and, at the same time, giving maximum profits. In this regard, they don't differentiate between CSA and conventional practices, giving preference to CSA practice only in the case when it is more

profitable than conventional one, for example, through input savings, decrease in labour intensity or increase in crop yields. A good example represents rapid uptake of mulching with plastic film – a cheap option, giving multiple benefits. Farmers also readily invest in zero- and minimal tillage machinery in the locations, where it has shown good results in terms of yield increases and cost reductions.

Even more preferential for farmers is when investments in their farms are made by the 3d parties (donors organisations' grants or governmental support), for example, through rural development projects. In this case they are willing to adopt any kind of agricultural practices, receiving financial support. According to several opinions expressed, multiple cases of projects implementation has already formed the "bad habit" among the Kyrgyz farmers and expectations to receive "everything for free", discouraging farmers from investing their own resources in innovative agricultural methods.

Meanwhile, adoption of a practice during a project doesn't automatically mean that farmers will continue using the practice after the funding is over. The percent of dis-adoption is rather high. This might be due to several reasons, for instance, due to the fact that the practice implemented was not properly tailored to the local conditions – this highlights the need for more context-specific selection of agricultural methods, which is at a core of climate smart agriculture approach.

However, an increasing number of investment initiatives occur in the country, mostly originating from wealthy farmers-innovators, possessing large areas of land: *"There are farmers who buy [equipment for CSA] themselves already, rather rich farmers. On Isyk-Kul, there are farmers who cooperate and buy together. And there are farmers, usually former state officers, who understand that this or that technology can bring something to them, if not to them, than to their*

children, and they buy these technologies, so there is progress" (expert). There are even cases of sponsoring CSA adoption from private sources, for example, a Maecenas who is establishing drip irrigated orchards in different provinces of Kyrgyzstan.

Undoubtedly, certain resistance to change from conventional practices remains in the form of preconceptions. Several highly innovative practices, as zero-tillage, are being resisted by the "farmers of the old school", taught at soviet times, that deep soil tillage and massive fertilization are key to successful agriculture. Scientific workers also informed about occurring resistant behavior towards water-saving irrigation methods, such as sprinkler irrigation, subsurface irrigation, impulse irrigation, discrete irrigation, from a number of farmers, who "percolate holes when they want in trays, brake trays, drive everything into non-functioning condition" (expert on irrigation). Obviously, these farmers were not duly explained the advantages which the water saving practices bring.

But overall, it can be seen that creation of legitimacy for CSA in Kyrgyzstan doesn't face open resistance from any group of stakeholders. And the barriers to change mainly originate from poor knowledge dissemination and lack of enabling environment. As one expert put it, *"It's not that someone strongly resists changes from ordinary agricultural practices to sustainable ones. This just requires attention from the government, the desire of the farmers themselves, the dissemination of knowledge and experience in this matter, and of course, financing"* (expert).

Structural causes of functional problems

The thorough analysis of each of the seven functions, which was performed in the previous chapter, allows to explore, whether the weakness of the function is linked to actors, institutions, interactions or infrastructure, as well as whether the problem occurs because any of these are missing or there is a problem with their capacity. Such analysis was carried out for all functions in order to identify where exactly the problem is, the results and detailed description can be found in the Table 21, Table 22, Table 23, Table 24, Table 25, Table 26, Table 27.

Table 21. Structural analysis of Function 1 (Farmers activities) weakness

Actors	Presence		
	Capacities	Low purchasing capacities of farmers	Kyrgyz farmers in majority cannot afford either high up-front costs of certain CSA technologies or taking risks trying new practices, uncertain of the final result.
		Low level of farmers' innovativeness	The majority of Kyrgyz farmers are characterized by inner laziness, reluctance to experiment and low innovativeness, which some expert explain by ethnic and cultural specificities.
		Capacity of international actors to identify applicable CSA methods, to design the project and the following upscaling	International actors at times lack capacity to conduct a proper applicability research before the practice implementation, which can cause project failure if it doesn't bring the expected results. The project design at times is not adjusted to the beneficiary

		process; to involve and train extension; to evaluate the project results	context: targeting wrong (not enough educated, non-initiative) farmers, which leads to high percentage of practice dis-adoption during and after the project termination, acting as practice anti-promotion. Often the project design also doesn't dedicate enough time to teaching farmers to use the practice appropriately, increasing the chances of practice dis-adoption. This partially may be due to the fact that the project fails to involve and/or properly train the extension services. Even less efforts and attention is given to the project results evaluation and the following upscaling process of the successfully adopted practices. Project funding solely by grants and failure to actively involve farmers' own resources can create wrong attitudes among farmers, since they don't sufficiently value things they get for free, which can lead to practices abandonment.
		Limited capacity of commercial extension agents	Extension agencies existing in the country function on commercial basis, which means they only perform limited number of activities funded by donors' projects, and provide information only on those practices, implemented through project interventions.
		Lack of central initiative and willingness to support CSA	Central Government in Kyrgyzstan position agriculture low in the list of country's priorities, which triggers almost full absence of state support to agriculture in general and transition to CSA in particular. Relying solely on international actors and donor's

			support, it at the same time fails to participate in international initiatives, which is necessary for creation of country ownership of the established through projects mechanisms and institutions.
Institu-tions	Presence	Wasteful behavior towards abundant and cheap resources (soft institutions)	Differences in innovativeness between southern farmers and farmers from the rest of the territory of Kyrgyzstan can be explained by the presence of soft institutions: the majority of Kyrgyz farmers got used to free/cheap and abundant resources (water, fertilizers, seeds etc.), which traditionally were supplied to them in soviet times.
		Habit to receive financial support for the implementation of CSA practices (soft institutions)	Frequent cases of full financing of practice implementation by project grants (including purchase of equipment), seldom requiring financial participation by farmer, doesn't stimulate own farmers initiatives. Farmers get used to receiving financial support, which stimulates farmers to wait for new grants instead of investing their own resources in innovations.
		Soviet legacy: preconceptions towards certain CSA practices (soft institutions)	Several highly innovative practices, as zero-tillage, are being resisted by the "farmers of the old school", taught at soviet times, that deep soil tillage and massive fertilization are key to successful agriculture.
		Absent incentives from the government (hard institutions)	Kyrgyz legislation and policies lack stimula for farmers to adopt and upscale CSA
	Capacity	Low water tariff (weak hard	Water fee in Kyrgyzstan is insufficient to encourage farmers to save water and to adopt costly water saving technologies, such as

		institution)	drip irrigation.
Interac tions	Presence	Connectivity problems: extension-farmers	Existing extension services are concentrated around the province centers and don't have representations in remote locations, which implies that not all farmers are embraced by the services
		Almost absent researcher-farmer interactions	Substantial decrease in number of contacts of research workers with farmers is caused by the cut-down of research field works and visits, and decreased research activity in agriculture in general
	Quality	Weak interactions farmer-farmer between districts	It is evidenced by the fact that information dissemination about successful CSA practices (such as plastic film mulching) disseminated rapidly within the district area but hasn't overcome the barrier of several kilometers to the neighboring district.
		Too strong ties: hierarchy in cooperatives	Strong hierarchy in relations, which existed in soviet collective farms, still persist nowadays in Kyrgyz voluntary cooperatives, constraining farmers' independent decision-making, fair distributions of resources and revenues
Infrast ructure	Presence	Physical infrastructure: some CSA equipment can not be used after land reform	Certain machinery and equipment owned previously by collective farms cannot be used nowadays because of farms separation, which has led to abandonment of several CSA practices and deterioration of drip irrigation infrastructure.
	Quality	Knowledge infrastructure: little number of practices elaborated specifically for local conditions	The number of CSA practices, which applicability specifically to local conditions and context of Kyrgyzstan was researched and proved by practical experience, is limited.

Table 22. Structural analysis of Function 2 (Knowledge development) weakness

Actors	Presence	Low number of international actors, active in the area of country-specific CSA research	The number of international initiatives performing research development projects on CSA in the Kyrgyz Republic is very limited
	Capacities	Poor capacities of research institutions	The number of scientific researchers decreased multifold, and the actual investigations and experimenting is not being performed. The activities of research institutions are mostly limited to elaborations on the results of previous research.
Institutions	Presence		
	Capacity		
Interactions	Presence	Absence of interactions national-international research actors	Few projects on CSA research in Kyrgyzstan fail to involve national research institutions and to use national research results, and, thus, don't base on existing knowledge developed in the country
	Quality		
Infrastructure	Presence		
	Quality	Low quality of knowledge infrastructure: deteriorated state research; absence of topic in education curricula; low access of farmers to research	State of agricultural research in the country has substantially deteriorated and is characterized by very limited research activity on the topic or full absence of such. Research is constrained by cross-institutional access to information: hydrometeorological institutions, for instance,

		results	consider climatic information secret. Farmers' access to research results is very limited because of the inadequate (not farmers-friendly) channels of information sharing (internet, low number of brochures).
		Poor financial infrastructure: scarce public funding of agricultural research	Low availability of state funds for agricultural research and reliance of central government on international support has led to drastic cut down of state financing of agricultural research

Table 23. Structural analysis of Function 3 (Knowledge dissemination) weakness

Actors	Presence	Insufficient number of national NGOs dealing with knowledge dissemination on CSA	Several NGOs are developing their training and dissemination programmes for SA and CSA, but their number is insufficient for the country scale transition
		Absence of ministry responsible for extension	In Kyrgyzstan there is no ministry in the government responsible for extension and rural advisory services
		Absence of public extension services	Rural Advisory Service (RAS), the main extension agency in KR, was founded by the World Bank and is financed only from donor sources. The other agencies and training centers also receive funding (and tasks) through projects. The state is not financing extension services in Kyrgyzstan.
	Capacity	Limited capacity of commercial extension agents	Extension agencies existing in the country function on commercial basis, which means they only perform limited number of activities

			funded by donors' projects, and provide information only on those practices, implemented through project interventions. Moreover, when the financing is stopped, they cannot continue their activities.
		Low capacity of national institutions	Institutional specialists lack capacity because institutional memory often gets lost in Kyrgyzstan because of high staff turnover. National institutions do not continue efforts made by international initiatives on knowledge dissemination among the next circle of recipients.
Institutions	Presence	Absent legislative framework for knowledge dissemination in agriculture	Extension and rural advisory services and knowledge dissemination in agriculture are not legally regulated.
		Soviet legacy: preconceptions towards certain CSA practices (soft institutions)	Knowledge dissemination is less successful because of persisting old preconceptions against such CSA practices, as conservation tillage and several others.
	Capacity		
Interactions	Presence	Connectivity problems: extension-farmers	Existing extension services are concentrated around the province centers and don't have representations in remote locations, which implies that not all farmers are embraced by the services
	Quality	Lack of trust of farmers to commercial extension services workers	Commercial extension agents at times promote the practice, applicability of which is questionable and was not sufficiently researched, intentionally highlighting only the advantages, and not informing about possible shortcomings. This discourages farmers

			from asking for their advice in the future.
Infrast ructure	Presence	Financial infrastructure for knowledge dissemination is absent	Extension and rural advisory services in Kyrgyzstan don't receive state financing
	Quality	Poor quality of knowledge infrastructure	The majority of the websites with information on CSA are lacking installation guidelines, schemes and details on the maintenance. Moreover, little efforts are made to inform the farmers about the existence of these information sources. Other sources of knowledge on CSA for farmers are very limited, and the access process is cumbersome. There is a restricted access to climatic data, which is considered secret by institutions in Kyrgyzstan.
		Physical infrastructure underdeveloped: poor internet access in rural areas	Currently only 54 % of individuals are using Internet in Kyrgyzstan, most of them are urban dwellers. Poor internet access makes information on the thematic websites inaccessible to many farmers

Table 24. Structural analysis of Function 4 (Guidance of the search) weakness

Actors	Presence		
	Capacity	Indifferent position of the central government	Central Government in Kyrgyzstan position agriculture low in the list of country's priorities, which triggers almost full absence of

			state support to agriculture in general and transition to CSA in particular. For the same reason, several draft policies, which were developed with the help of international partners, were not adopted by the Government of the Kyrgyz Republic (drafts of the State Program for the Conservation and Improvement of Soil Fertility, the Program for Improving the Meliorative State of Irrigated Lands, the Integrated Programme for Sustainable Land Management).
Institutions	Presence	Presence of constraining legislation and policies (hard institutions)	Certain old legislation and policies are constraining adoption of several climate smart practices: Forest Code is constraining agroforestry development, land tenure of pasture land (owned by the state) is constraining sustainable pasture management.
		Absence of efficient state policies for CSA (hard institutions)	Specific policies and strategies, and detailed action plans are absent, many documents are outdated and the new ones were not developed and/or adopted
	Capacity	Underdeveloped legislative/policy framework for CSA (hard institutions)	Existing policies often don't articulate the ways for achieving announced objectives, and fail to show the actual pathway for transition to CSA. The existing laws and strategies receive weak enforcement.
Interactions	Presence		
	Quality		
Infrast	Presence	Financial infrastructure for creating a solid legislative base	The lack of money in the state budget is the main excuse for not developing/implementing/enforcing regulations on CSA. The

ructure		on CSA is missing	country is lacking financial strategy for mobilizing resources from private sources and international funds.
	Quality		

Table 25. Structural analysis of Function 5 (Market formation) weakness

Actors	Presence	Absence of home producers of CSA machinery	Own machinery production for CSA in Kyrgyzstan is not developing. The exception is production of equipment for drip irrigation in Bishkek.
		Absence of suppliers of good quality agricultural machinery	The country experiences the deficit of good quality machinery for agriculture
	Capacity		
Institut ions	Presence	Eating habits of Kyrgyz people – don't consume pulses (soft institution)	The inner market for pulses in Kyrgyzstan is nearly absent, because Kyrgyz people traditionally consume large amounts of meat, and almost don't include pulses into their diet
		Presence of strict international standards (hard institutions)	A number of standards on the international market constrain exports of Kyrgyz agricultural produce outside Kyrgyzstan
	Capacity		
Interac	Presence	Missing interactions with permanent buyers of certain	There are no pre-orders and interlinked contracting for a number of crops, such as potatoes, onions, wheat and many others. Because

tions		crops	of this farmers experience lack of demand and difficulties with realization of their produce.
	Quality		
Infrast ructure	Presence	Physical infrastructure missing: labs for international seeds certification	High quality seeds, complying with international standards are only registered through one lab in the country, which passed 4th accreditation of ISTA.
	Quality		

Table 26. Structural analysis of Function 6 (Resources mobilisation) weakness

Actors	Presence		
	Capacity	Low purchasing capacities of farmers	Financial resources of the majority of Kyrgyz farmers are scarce, for this reason they cannot afford either high up-front costs of certain CSA technologies or taking risks trying new practices, uncertain of the final result.
		Lack of central initiative and willingness to support CSA	Central Government in Kyrgyzstan position agriculture low in the list of country's priorities. For this reason, the state support for agriculture in general, and for transition to CSA in particular, is inadequately low, even taking into account the limited capacity of the State budget of the Kyrgyz Republic.

Institutions	Presence		
	Capacity		
Interactions	Presence		
	Quality	Underdeveloped interactions with potential donors of CSA projects	Although a number of international actors and donors are active in the field of CSA implementation in Kyrgyzstan, the volume of international funding stays limited, especially for countrywide CSA dissemination and upscaling. The potential interactions with Green Climate Fund, for instance, are on the initial phase of development.
Infrastructure	Presence	Absence of crop insurancing (financial infrastructure)	Crop insurancing is not developed in Kyrgyzstan. Insurance companies are unwilling to do this because of the complicated weather conditions.
	Quality	Poor quality of credit system (financial infrastructure)	The system of crediting and microcredits for agriculture in Kyrgyzstan is poorly developed. State subsidized preferential credits are limited and available to a very small number of farmers.

Table 27. Structural analysis of Function 7 (Creation of legitimacy) weakness

Actors	Presence		
	Capacity	Farmers' reluctance to invest in agriculture	Farmers tend to avoid large investments in agriculture in general, considering the returns to be not sufficient enough to justify it.

		Capacity of international actors to identify applicable CSA methods and to design the project	International actors at times lack capacity to conduct a proper applicability research before the practice implementation, which can cause project failure if it doesn't bring the expected results. This also leads to high percentage of practice dis-adoption during and after the project termination, acting as practice anti-promotion. Project funding solely by grants and failure to actively involve farmers' own resources can create wrong attitudes among farmers, since they don't sufficiently value things they get for free, which can lead to practices abandonment.
Institutions	Presence	Soviet legacy: preconceptions towards certain CSA practices (soft institutions)	Several highly innovative practices, as zero-tillage, are being resisted by the "farmers of the old school", taught at soviet times, that deep soil tillage and massive fertilization are key to successful agriculture.
		Habit to receive financial support for the implementation of CSA practices (soft institutions)	Frequent cases of full financing of practice implementation by project grants (including purchase of equipment), seldom requiring financial participation by farmer, doesn't stimulate own farmers initiatives. Farmers get used to receiving financial support, which stimulates farmers to wait for new grants instead of investing their own resources in innovations.
		Land reform (hard institution)	The land reform after the breakdown of the USSR has fragmented land of collective farms to the farming plots of very small size, which makes purchase of expensive equipment by farmers economically unreasonable.

	Capacity	Underdeveloped legislative and policy framework for CSA (hard institutions)	Kyrgyz legislation and policies lack stimula for farmers to adopt and upscale CSA. Existing policies often don't articulate the ways for achieving announced objectives, and fail to show the actual pathway for transition to CSA. The existing laws and strategies receive weak enforcement.
Interactions	Presence		
	Quality		
Infrastructure	Presence		
	Quality		

Recommendations

Construction procedure of the holistic systemic instrument

The recommended solutions (mechanisms) for enhancing the process of transition to climate smart agriculture in the country of Kyrgyzstan were based on the findings of this research, and are represented by the list of systemic instruments aimed to overcome the identified systemic problems in the given TIS.

According to Wieczorek and Hekkert 2011, suggested systemic instruments should be selected in a way, so that they mutually reinforce each other. The vague and unclear procedure of selection was improved by the current study, and the following way of instruments selection and prioritization was proposed:

- All the causes of the systemic problems are mapped on one sheet;
- Causal relations among them are identified and depicted with arrows on the map, leading from the causal element to the effected element;
- The items with the largest number of causal links are identified (those which create the biggest number of effects on the others) and prioritized as highest priority, thus requiring the most urgent action and the biggest effort of intervention;
- Cycles identified, where one targeted intervention on the prioritized cause triggers improvement for other connected causes;
- Instruments suggested for the prioritized elements;
- Supporting instruments (addressing less prioritized causes) suggested that could significantly enhance the impact of the main instruments.

According to the proposed procedure, the causes of the systemic problems were mapped and the causal links were built among the elements. The systemic problem causes map can be seen on the Figure 19.

The 1t level elements (3-5 links) identified (those having the biggest number of causal links and thus having the biggest effect on the other elements) are:

- Lack of central initiative and willingness to support CSA
- Underdeveloped interactions with potential donors of CSA projects
- Capacity of international actors to design the projects (including, identifying applicable CSA methods, training extension, performing evaluation and upscaling)

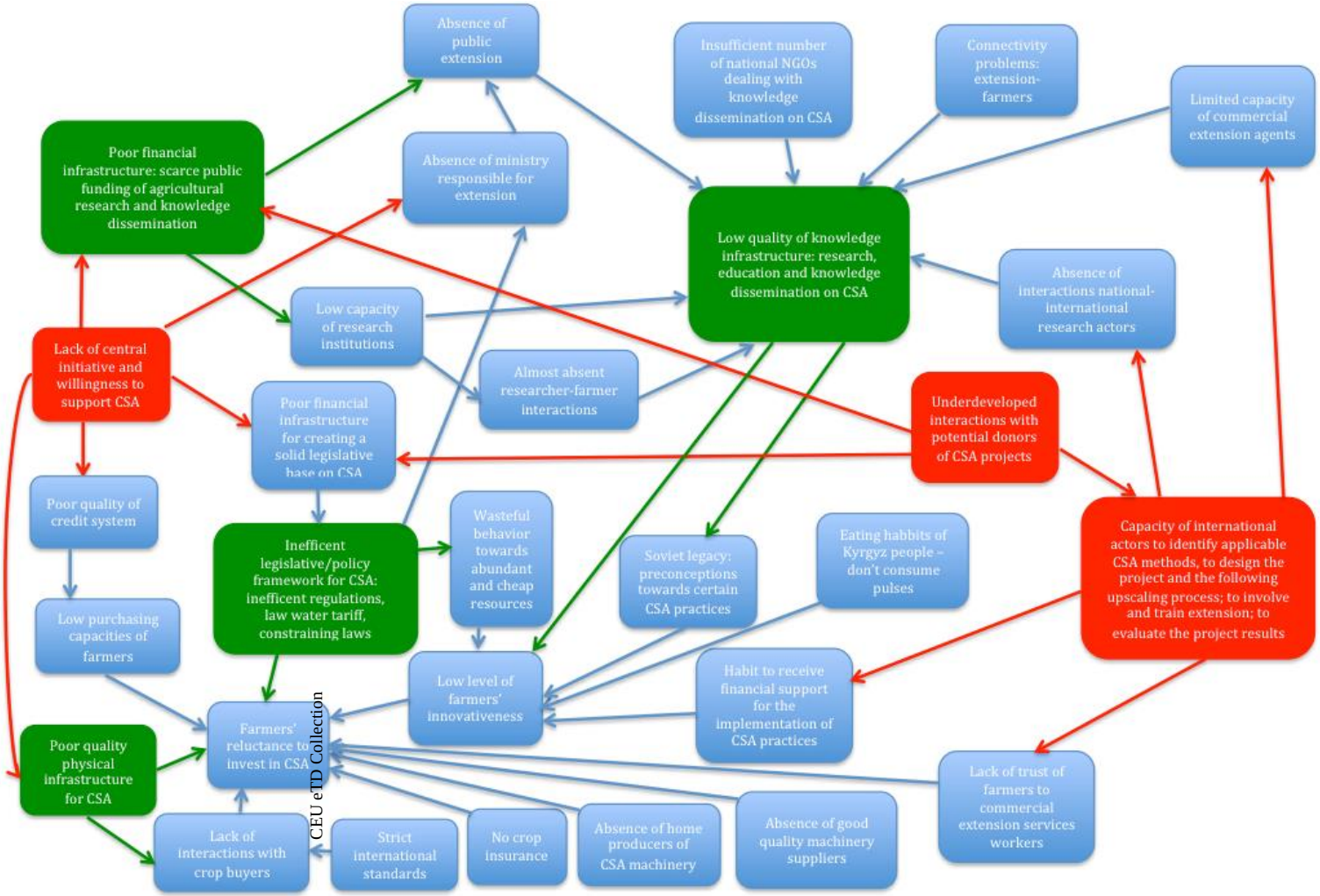
The 2d level elements (2 links) were also found to have important causal effect on a big number of "smaller" causes, and all appear to trigger "infrastructural" problems:

- Poor financial infrastructure: scarce public funding of agricultural research and knowledge dissemination;
- Low quality of knowledge infrastructure: research, education and knowledge dissemination on CSA;
- Poor quality of physical infrastructure for CSA;
- Inefficient legislative/policy framework for CSA.

On the map it is evident that overcoming the causes of 1t and 2d level would have a positive effect on overcoming a number of 3d level causes of systemic problems, that's why 1t and 2d level elements should be put at the core of the integrated systemic instrument to be proposed.

A number of 3d level elements are not linked to higher-level ones, and should be given proper attention when building the systemic instrument as well.

Figure 19. Map of causal relations between systemic problems



Need for cooperative structures in Kyrgyzstan

According to the Ministry of Agriculture of the Kyrgyz Republic, nearly 60 percent of the rural residents are not willing to unite in cooperatives. Their reluctance is explained by the bad experiences faced during soviet times and first years of country independence, and due to the lack of trust to the Government.

"There was time, when we were trying to create enlarged farm, cooperative in order to involve more land, capacities accordingly and with this to provide more people with jobs, and to produce more agricultural produce. But for some reason, we failed" (farmer 1). *"In general, as much as I can judge from my experience, all the cooperatives in our conditions in Kyrgyzstan – is not a successful option it turned out. In reality, it's a bit vague. In reality no real cooperatives exist."* (farmer 2). According to the farmers, one of the problems with cooperatives is lack of transparency, abuse of power by the main manager of the cooperative, and the lack of the adequate legislative framework: *"..in reality based on my experience, the cooperatives are the worst for its members, because they are the least transparent. ..they failed to determine this in written form in the same way. And obviously, this is the reason."* (farmer 2). *"..the manager, as a rule, has more privileges and more power in the distribution of the benefits in the cooperative"* (farmer 3). *"The size of the profit should be in accordance to the input introduced. But in reality it is a bit different. In reality there is an administrator/manager, who is respected and who everybody subdue to. And is actually decides on everything. The members of the cooperative get some profit of course, but they get just a salary like a hired labour, and the actual cooperative profit they don't get."* (farmer 2).

However, there is a common opinion among the experts, that sooner or later, some form of agricultural cooperation should be implemented. The majority of farmers from those interviewed agree with it too.

Proposed solution

The proposed integrated instrument represents a holistic approach for solving multiple systemic problems identified in the system through targeting systemic causes of 1t and 2d level and unconnected 3d level causes. The resting causes are getting eliminated by "avalanche" effect.

At the core of the proposed solution lies the idea of so-called **"agro-clusters"**. According to this idea, the smallholder farmers in Kyrgyzstan should be organised in clusters, each headed by one larger agroholder-innovator, who have a proven record of applying CSA technologies on their farms. The organization type of agro-clusters would have similarities to agricultural cooperatives in a way that the leading agroholder would have big authority for member-farmers in terms of identifying suitable agricultural practices (climate smart) and promoting efficient use of resources. In addition, an agro-cluster would have characteristics as following:

- Leading agroholder purchases machinery, equipment and rents it to farmers or sells it in leasing with favourable percent (1-2%);
- Leading agroholder produces/purchases high quality seeds and distributes among farmers as an interest-free loan;
- Agroholder may differentiate crop production by farmers, with specialization on certain crops (optional);
- Agroholder purchases farmer's produce at a fixed in advance price – contracting;

- Agroholder then sells the produce through well established channels abroad and/or process on own factories
- Each agro-cluster has its own extension services serving for education and training of farmers on CSA. For these purposes several farmers-members should be converted into extension workers (they, according to Rogers 2003, would be more trusted by other farmers, than strangers).
- Lead argoholder-innovator (further, the head of the agro-cluster) receives benefits from the state, such as tax benefits, low export tariffs etc.
- The head of the agro-cluster also benefits from the secured market for selling seeds produced; receives steady supply of agricultural goods, which can be processed on the local processing station or factory; and gets revenues from renting/leasing the machinery.

The "agro-cluster" initiative should be center-led, with active participation of the state in order to perform the re-organisation reform and introduce regulatory policies for agro-clusters.

It is proposed that on the initial stage the pilot conducted for arranging one or two experimental agro-clusters to accumulate the first experience, to monitor its performance, to analyse the possible mistakes and correct them before upscaling the project to the full size. The pilot project can be led by FAO or UNDP with financial support from EBRD or GIZ.

The main project would require much larger financing, and would include development of the policy framework, and upscaling of agro-clusters system to the scale of the country. In this situation it is proposed to apply for co-financing by Green Climate Fund (GCF), EBRD/GIZ, European Union with a small share by the Ministry of Agriculture of the Kyrgyz Republic.

The probability of the proposed idea to succeed in Kyrgyzstan is supported by the following:

- Agricultural risks that small-holders are facing, especially those arising from adoption of new CSA technologies, are taken away from farmers (through contracting, guaranteed produce purchase and fixed pricing, interest-free seeds supply and cheap machinery leasing, constant guidance and advice by leading agroholder);

- There is a real (and very successful) example existing in Kyrgyzstan of the agrocluster-type organisation, established on the place of the former soviet cooperative, which is led by the innovative agroholder, and possesses almost all the features of the proposed agro-cluster (Ltd. "Atalyk");

- Because of the soviet legacy, the mentality of Kyrgyz farmers still incline to hierarchy, so with very high probability they would respect the authority of the head agroholder and listen to his advices. *"..here also a mentality is working, that eventually this hierarchy of power for people means more that liberty. They prefer that someone decides for them.."* (farmer);

- There are good chances to receive funding from the GCF, because the Fund is focused on financing only truly transformational projects for mitigation and adaptation to climate change, and climate smart agriculture falls within several of the Fund's strategic impacts. Moreover, the Kyrgyz Republic is currently finalizing GCF Readiness Programme, which was meant to fully prepare the country for engagement with the Fund.

The way the proposed integrated systemic instrument addresses the causes of systemic problems, identified before, is shown in the Table 28.

Table 28. Causes of systemic problems and the ways the proposed systemic instrument addresses them

№	Cause of systemic problem	Solution by the integrated instrument
1	Low purchasing capacities of	High up-front costs of certain CSA technologies are

	farmers	shared by members of agro-cluster by creating machinery pool. Concessional credit and interest-free loans are given for input purchase. Risks associated with trying new practices are overcome by agricultural insurancing and other risk-management tools, like inter-linked contracts, used in agro-clusters.
2	Low level of farmers' innovativeness	The inner laziness, reluctance to experiment and low innovativeness of the Kyrgyz farmers would be affected by the new order of things: farmers, encouraged by positive examples around in the agro-cluster and positively influenced by the authority of the agrocluster head, would become more willing to innovate.
3	Farmers' reluctance to invest in agriculture	No need of large investments since the majority of machinery is common pool, risks are minimized and returns are increased due to adoption of new climate smart technologies.
4	Lack of central initiative and willingness to support CSA	The Government gets involved, but level of financial participation required is low and don't create a burden for the state budget. Moreover, the agro-clusters project would gradually increase the interest of the center, stimulating participation in the fate of the Kyrgyz agriculture
5	Absence of ministry responsible for extension	The need for a ministry in the government responsible for extension and rural advisory services disappears, since extension becomes decentralized: in each agrocluster under the responsibility of the head agroholder.
6	Absence of public extension services	Same as above: the problem is solved by decentralisation of extension.
7	Limited capacity of commercial extension agents	No need for commercial extension services; farmers converted into extension agents in agro-clusters perform much better and are given more

		trust by the rest of farmers.
8	Insufficient number of national NGOs dealing with knowledge dissemination on CSA	Organisation of the knowledge dissemination is responsibility of the agro-cluster head, and is performed through extension services of the agro-cluster.
9	Capacity of international actors to identify applicable CSA methods, to design the project and the following upscaling process; to involve and train extension; to evaluate the project results	The proposed systemic instrument, which also took into account all previous mistakes, can be put at the core of the project to be implemented. Pilot can provide the first experience, and its evaluation and analysis can give base for corrections and further improvements before countrywide scaling up of the agro-clusters.
10	Absence of home producers of CSA machinery	It is expected that development of the own machinery production for CSA in Kyrgyzstan will sparkle since the demand will substantially increase. In anticipation of this, agroholders-heads of agro-clusters can purchase machinery from abroad, having for this more opportunities, than smallholder farmers.
11	Absence of suppliers of good quality agricultural machinery	Same as above.
12	Absence of efficient state policies for CSA (hard institutions)	A detailed governmental decree on agro-clusters should be adopted, describing the process of agro-clusters creation, its organisational structure, and clearly spelling out the responsibility of the head and farmers in it.
13	Absent legislative framework for knowledge dissemination in agriculture	The Governmental Decree “on agro-clusters” would include point, spelling out the responsibility of head-agroholders to arrange extension services in the agro-cluster, and the responsibility of the extension services to disseminate knowledge on CSA among farmers of the agro-cluster.

14	Inefficient legislative/policy framework for CSA (hard institutions)	Same as above: Governmental Decree "on agro-clusters".
15	Low water tariff (weak hard institution)	No need to increase water fee, since water saving is executed through adoption of water-efficient technologies, encouraged by the head in agro-cluster.
16	Land reform (hard institution)	The problem of fragmentation is solved by conglomerating lands and creating machinery pools in agro-clusters.
17	Soviet legacy: preconceptions towards certain CSA practices (soft institutions)	Preconceptions mentioned are the result of lack of knowledge, and can be overcome by farmer's education and awareness rising on CSA through extension services in agro-clusters.
18	Eating habits of Kyrgyz people – don't consume pulses (soft institution)	Promotion of diet with pulses inclusion, informing about pulses benefits for health; demonstration of receipts for pulses dishes, performed by the extension services in agro-clusters, can increase popularity of pulses and their consumption.
19	Connectivity problems: extension-farmers	Problem solved, since extension services are present in every agro-cluster; extension agents are same farmers, known and trusted more than commercial agents; they can use common language and find understandable words to explain CSA to other farmers of the agro-cluster.
20	Lack of trust of farmers to commercial extension services workers	Same as above.
21	Almost absent researcher-farmer interactions	The number of indirect contacts of research workers with farmers can be increased through intermediation of the head-agroholder.
22	Weak interactions farmer-farmer between districts	Frequent Farmer days, demonstrations, CSA fairs organised by the extension services in the agro-

		cluster would increase interactions among its members. Agro-cluster becomes a strong network, creating close links and connections among farmers.
23	Too strong ties: hierarchy in cooperatives	Strong hierarchy in relations in Kyrgyzstan can be converted into a positive feature: the authority of the head-agroholder is used to stimulate adoption of sustainable and climate smart agricultural practices, to influence farmer's decision-making in a sustainable direction.
24	Missing interactions with permanent buyers of certain crops	Heads of agro-clusters arrange contracts with permanents buyers of crop produce, or act themselves as buyers through inter-linked contracting with farmers of the agro-cluster.
25	Underdeveloped interactions with potential donors of CSA projects	After the pilot project, a funding proposal for Green Climate Fund on CSA upscaling in Kyrgyzstan should be developed.
26	Physical infrastructure: some CSA equipment can not be used after land reform	The proposed instrument includes new land reform, when fragmented farms would be united in cooperative units - agroclusters under the lead of the head agroholder-innovator. Each agro-cluster would have a machinery pool and CSA technologies supplied by the head.
27	Physical infrastructure underdeveloped: poor internet access in rural areas	Internet access with high likelihood is already available to agroholders-innovators, who collects information on applicable CSA options and then disseminates it among farmers. Knowledge dissemination among farmers performed through different, more farmer-friendly channels: face-to-face discussions and demonstrations, Farmer Days, farmer gatherings.
28	Physical infrastructure missing: labs for international seeds	Seeds are provided by he head-agroholder, who produces or buys them and makes sure the quality is high.

	certification	
29	Knowledge infrastructure: little number of practices elaborated specifically for local conditions	The experience accumulated in agroclusters after certain time span would serve as learning-by-doing. Heads of agro-clusters could also potentially organize their own research activities and experimenting within the agro-cluster. Or heads of agro-clusters could serve as intermediators with research institutions to implement their research results in practice.
30	Low quality of knowledge infrastructure: deteriorated state research; absence of topic in education curricula; low access of farmers to research results	Heads of agro-clusters could also potentially organize their own research activities and experimenting within the agro-cluster. Or heads of agro-clusters could serve as intermediators with research institutions to implement their research results in practice. Like this access of farmers to research results would increase many fold. Agro-clusters would have own extension services for educating farmers.
31	Poor quality of knowledge infrastructure on CSA: poor or restricted access to information	The search of information organised by the experienced lead agroholder would give more chances to get access to the needed information and knowledge.
32	Poor financial infrastructure: scarce public funding of agricultural research	Public research could be substantially supported the learning-by-doing experience accumulated in agro-clusters after certain time span, helping to get valuable research results. Heads of agro-clusters could also potentially organize their own research activities and experimenting within the agro-cluster.
33	Financial infrastructure for knowledge dissemination is absent	Problem solved by decentralisation of extension and it's concentration under the responsibility of the heads of agro-clusters. Lead agroholders would be interested in financing extension services within their agro-cluster, since the agro-cluster system will significantly increase their profits.

34	Financial infrastructure for creating a solid legislative base on CSA is missing	Substantial funds can be mobilized for the proposed Green Climate Fund project, with minimal financial participation by the Ministry of Agriculture of the Kyrgyz Republic.
35	Absence of crop insurancing (financial infrastructure)	Climate index-based insurance is proposed as one of the risk management tools to be used in agro-clusters.
36	Poor quality of credit system (financial infrastructure)	Low-interest credit would be available for farmers in agroclusters. Interest-free loans would be provided for inputs purchase, and cheap leasing schemes would be available for CSA equipment, which can't be used as common pool resource.

Results for Uzbekistan, Kazakhstan, Tajikistan, Turkmenistan and discussion

In the previous chapters the situation in Kyrgyzstan, where the rich data was collected due to additional field visits and in-depth interviews with experts and farmers, was analysed with the help of improved Wieczorek&Hekkert analytical framework, and the integrated policy instrument was developed.

In this chapter the results of expert focus group discussions in 4 countries (Uzbekistan, Kazakhstan, Tajikistan and Turkmenistan) will be described and analysed (for the results of the online questionnaire see Appendix B). The inability to perform in-depth interviews with experts and farmers in these countries prevented the Author from using the improved Wieczorek&Hekkert analytical framework for analysis in the full format. However, based on the available data, the functional analysis will still be performed to the extent possible, and the failures in the systems will be identified (see Table 29, Table 30, Table 31, Table 32). These failures will be compared to the solutions proposed by the experts during the workshop. Finally, based on the matches obtained, the conclusions will be made, whether these solutions are potentially capable to address the failures identified in the systems.

Uzbekistan

The main 3 challenges posed by climate change in the agricultural subsectors in Uzbekistan, as identified through expert focus group discussion are the following:

- In crop subsector:

- Reduced crop (yield) production on both irrigated and rain-fed agricultural lands due to high soil salinisation, lack of water and droughts, soil degradation, plant diseases (the most vulnerable crops are wheat, cotton and rice);
- Reduced water resources due to water scarcity and droughts on rain-fed lands and rangelands, which cause further soil salinisation and degradation;
- Soils – erosion and nutrient depletion of arable lands and pastures.

- In livestock subsector:
  - Increased spread of livestock diseases & parasites;
  - Reduced availability of forage for livestock;
  - Bad rangeland management.

In order to address these challenges, the experts identified the following interventions as the highest priority:

- Increase forage production using marginal lands;
- Improved management of watersheds, including small ones; water harvesting on desert pastures;
- Adaptation taking into account desert ecosystems;
- Sustainable intensification: research, infrastructure improvement and creating the system of planning and management;
- Soil erosion prevention in mountain and rainfed areas, and in desert rangelands: improve access to soil-protecting technologies and seed material, seed multiplication, nurseries creation; organic agriculture development;

- Agroforestry upscaling: changing land lease terms, creation of incentives;
- Development of the system of rural advisory services.

Meanwhile, discussing the CSA national programme in Uzbekistan, the following main objectives to be achieved were highlighted by the experts:

- Use/implementation of CSA technologies should ensure the stability and sustainability of incomes;
- To ensure the diversification of production (with fruits and vegetables);
- Increase productivity;
- Improving soil quality;
- Minimization of risks (economic and environmental);
- Reduce the vulnerability of agriculture to climate change;
- Saving water;
- Ensuring sustainable ecosystem services.

Experts identified several gaps in analysis and data to establish an evidence base to support CSA policies and programmes in Uzbekistan:

- Lack of data on the state (quality) of lands;
- Lack of data on the state of pastures and livestock;
- Risk Analysis (including climatic);
- Lack of forecasting data;
- Lack of data on the economic evaluation of ecosystem services.

They deem *introduction of electronic agriculture* to be the most important improvement needed to ensure that the knowledge/evidence base created is shared and used effectively.

Among the government, donor and regional finance mechanisms to support the implementation of a CSA approach in Uzbekistan, the experts deem most important are international and regional donor organisations, international development and research organisations and banks, including: International Fund for Agricultural Development (IFAD), Green Climate Fund (GCF), World Bank, Islamic Development Bank (IDB), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Global Environmental Facility (GEF), USAID, Asian Development Bank (ADB), Melioration Fund, Environmental Protection Fund (EPF), Reconstruction and Development Fund, Shanghai Cooperation Organisation Banks, Eurasian center, Consortium of International Agricultural Research Centers (CGIAR). The experts consider as well important the development of private financing.

They highlighted also that avoidance of duplication of financing and a proper coordination need to be performed in the country.

Among knowledge, research and extension services gaps to support implementation of CSA strategy in Uzbekistan, experts highlight:

- Lack of specific knowledge on CSA;
- Need to align CSA with country priorities;
- Need to specify knowledge available locally and globally on innovation in the field of CSA;
- Strengthening institutions, partnerships and collaboration;
- Creating enabling environment.

The following measures were proposed:

- Establish linkages between innovation system actors;
- Establish rural advisory service system;
- Improve access to information;
- Update databases;
- Conduct trainings;
- Rely on young educated staff;
- Support local institutions, increase funding for research on climate change and adaptation of CSA technologies appropriate for Uzbekistan.

In particular, experts specify that the following measures should be taken by knowledge and research institutions in Uzbekistan:

- Demonstration of CSA practices and creation of awareness about CSA (conferences, workshops etc.);
- Conduct research on CSA technologies appropriate for Uzbekistan, adaptation of CSA innovations for conditions of Uzbekistan and development of local knowledge in the field of CSA;
- Analysis of value-chains before introduction of new technologies (namely, value-chains of legumes);
- Establishing of innovative platform for CSA practices;
- Strengthening innovative capacity of actors about innovations, value chains etc.;

- Knowledge and information dissemination, capacity building of farmers;
- Creating mobile applications for farmers;
- Development of linkages between actors of the market.

Experts have summarized the main barriers for transition to a CSA in Uzbekistan as following:

- Poor access of farmers to knowledge on CSA approach and technologies;
- Lack of access for farmers to financial resources (micro-credit);
- Insufficiently developed network of rural advisory/extension services;
- A weak system of incentives;
- Lack of funding for agricultural research;
- Limited access to input/output markets.

And eventually, the following enabling environment interventions to overcome the existing barriers were suggested by experts taking part in the focus group discussions:

- Development of a system of rural advisory services;
- Strengthening the links between producers and consumers of knowledge;
- Enhancing capacity of farmers;
- Improvement of legislation in the area of crediting and provision of advisory services (regulations on the extension services);
- Improving the efficiency of extension services and control;
- Extend existing incentive scheme on CSA technologies;

- Increase financial incentives for research institutes' employees;
- Increasing investment in research, material and technical base and increasing scientific potential;
- Increase the share of funding for climate research;
- Development of markets and market relations between stakeholders;
- Strengthening the development of the value chain: post-harvest technologies (storage, processing, transportation, standardization and certification, etc.).

Table 29. Functional analysis of AIS in Uzbekistan

Function	Type of failure	Description of failure	Corresponding solution, proposed by experts
Function 1 - *Farmers' innovative activities*	Actors presence/capability		Enhancing capacity of farmers; Strengthening innovative capacity of farmers about innovations, value chains etc.; Conduct trainings
	Interactions presence/intensity		Establish linkages between innovation system actors
	Hard institutions presence/capacity		Strengthening the development of the value chain: standardization and certification
	Physical infrastructure presence/quality		Strengthening the development of the value chain: post-harvest technologies (storage, processing, transportation); Creation of nurseries.
Function 2 - *Knowledge development*	Actors capabilities		Increasing scientific potential; Strengthening innovative capacity of actors about innovations, value chains etc.; Conduct trainings

	Interactions presence/intensity		Introduction of electronic agriculture; Strengthening partnerships and collaboration
	Financial and knowledge infrastructure quality	Lack of funding for agricultural research Lack of data on the state (quality) of lands; on the state of pastures and livestock; on risk analysis (including climatic); on the economic evaluation of ecosystem services; lack of forecasting data; Lack of specific knowledge on CSA	Increasing investment in research, material and technical base; Increase the share of funding for for research on climate change and adaptation of CSA technologies appropriate for Uzbekistan; Increase financial incentives for research institutes' employees Improve access to information; Update databases; Introduce electronic agriculture; Conduct research on CSA technologies appropriate for Uzbekistan, adaptation of CSA innovations for conditions of Uzbekistan and development of local knowledge in the field of CSA
Function 3 - *Knowledge dissemination*	Actors presence/capabilities	Insufficiently developed network of rural advisory/extension services	Development of a system of rural advisory services; Improving the efficiency of extension services; Conduct trainings.
	Interactions presence/intensity		Strengthening the links between producers and consumers of knowledge; Demonstration of CSA practices and creation of awareness about CSA (conferences, workshops etc.); Introduction of electronic agriculture
	Hard institutions presence/capacity		Improvement of legislation in the area of advisory services (regulations on the extension services); Improving control over extension services
	Physical and knowledge	Poor access of farmers to	Creating mobile applications for farmers;

	infrastructure presence/quality	knowledge on CSA approach and technologies	Establishing innovative platform for CSA practices
	Hard institutions presence/capacity	Need to align CSA with country priorities; A weak system of incentives for CSA implementation	Creating enabling environment for CSA; Change land lease terms to enable agroforestry upscaling; Extend existing incentive scheme on CSA technologies
Function 5 - *Market formation*	Actors presence/capability		Improve access to soil-protecting technologies and seed material
	Interactions presence/intensity		Development of market relations between stakeholders;
	Physical and financial infrastructure presence/quality	Limited access to input/output markets	Development of markets; Improve access to soil-protecting technologies and seed material
Function 6 - *Resources mobilization*	Interactions presence/intensity	Duplication of financing	Proper coordination of financial flows; Increase collaboration with donor organisations and private investors
	Hard institutions presence/capacity		Improvement of legislation in the area of crediting
	Financial infrastructure quality	Lack of access for farmers to financial resources (micro-credit)	

Kazakhstan

The main challenges posed by climate change in the agricultural subsectors in Kazakhstan, as identified through expert focus group discussion are the following:

- In crop subsector:
    - Reduced yields for all types of crops in steppe, semi-desert and desert zones;
    - Flooding, heavy rainfall, late spring and early autumn frosts in all zones;

    - Reduced water resources due to water scarcity and droughts on the south of Kazakhstan;
    - Increased growth of weeds, pests and fungi in all zones;
    - Wind erosion in steppe, semi-desert and desert zones.
- In livestock subsector:
    - Increased spread of livestock diseases and parasites in all zones;
    - Reduced availability of drinking water and forage for livestock due to water scarcity and droughts in steppe, semi-desert and desert zones;
    - Decreased livestock health and welfare due to heat stress, reduced fertility and milk production in steppe, semi-desert and desert zones.

In order to address these challenges, the experts identified the following interventions as the highest priority:

- Sustainable increase in crop diversity including drought-, salt-, and stress-resistant crops in Almaty and Akmola regions;
- Management of water supply and irrigational systems in Zhambyl region and Southern Kazakhstan;
- Ecosystem services & adaptation with respect to ecosystem features in Almaty and Kyzylordyn regions;
- Sustainable agroforestry in Almaty region;
- Conservation of genetic resources in Almaty region;

- Soil-conserving and resource-saving technologies in Almaty and Akmola regions;
- Organic farming development in all regions;
- Training and capacity building of all stakeholders in all regions.

Meanwhile, discussing the CSA national programme in Kazakhstan, the following main objectives to be achieved were highlighted by the experts:

- Increasing awareness and knowledge;
- Enabling access to CSA technologies;
- Obtaining stable crop yields and productivity of livestock;
- Stable livelihoods and incomes for agricultural producers;
- Development of system of incentives and insurance for CSA;
- Development of CSA technology package (soil conservation, organic farming, water-saving, soil protecting technology, etc.), its demonstration and implementation at the local level;
- Long-term weather forecasts for disaster risk reduction and rapid alert system for the producers.

Experts proposed several improvements needed to ensure that the knowledge/ evidence base is created, shared and used effectively to support CSA policies and programmes in Kazakhstan:

- Transfer of knowledge to farmers: the publication of printed and video products, manuals and methodologies;
- Development of a national strategy for extension services;

- Ministry of agriculture should provide the best technology replication through exchange visits of farmers implementing CSA;
- On the national level, to create a call center to provide farmers with information;
- Distribution of fast information to producers about meteorological conditions, sowing dates and disaster probability.

Among the government, donor and regional finance mechanisms to support the implementation of a CSA approach in Kazakhstan, the experts deem most important to be the governmental programmes, as well as financial support from such donors and international organisations, as Green Climate Fund (GCF), World Bank, Food and Agriculture Organisation of the United Nations (FAO), United Nations Development Programme (UNDP), Global Environmental Facility (GEF)/Small Grants Programme (SPG).

In order to overcome certain knowledge, research and extension services gaps to support implementation of CSA strategy in Kazakhstan, experts proposed the following measures:

- Collect information on current studies on CSA in Kazakhstan, organize research (surveys, collection of information, analyses of technology and implemented positive experience).
- Analyze legal and policy documentations, perform necessary amendments for legal support of CSA process. Develop of recommendations, programs and strategies etc.
- Learn international experience on CSA and adapt it to the climatic zones of Kazakhstan;
- Improve access to data bases, cooperation with countries;

- Adapt the knowledge and international experience, successful practices of CSA for easy understanding by farmers;
- Creation of info graphics, video-books, brochures etc.;
- Financial and resources (land, machinery) support by international organisations.

In particular, experts specify that the following measures should be taken by knowledge and research institutions in Kazakhstan:

- Search for technology directed to increase of agricultural productivity in the context of climate change and adaptation it for farms;
- Creation of database and information platforms on CSA for information exchange;
- Creation of demonstration fields on CSA technologies;
- Exchange visits.

Experts have summarized the main barriers for transition to a CSA in Kazakhstan as following:

- Low level of knowledge and awareness;
- Insufficient legal framework;
- The weak technological base and low levels of farming culture;
- Lack of coordination between sectors (local, district, regional, scientific, etc.);
- Low awareness of decision-makers;
- Lack of demonstration plots for dissemination of CSA technologies;
- The lack of information about CSA technologies among scientists, farmers and decision-makers.

And eventually, the following enabling environment interventions to overcome the existing barriers were suggested by experts taking part in the focus group discussions:

- Creating extension services for introduction of new technologies;
- Working on the legal acts and improvement of the regulatory framework;
- Attracting investments and development of state sector program;
- Creating a system of coordination for the implementation of CSA;
- Permanent information and training program for all levels of the government;
- To choose pilot areas in all climatic zones of Kazakhstan for the replication of best practices;
- Conducting a wide promotion of CSA and implementation of educational programs.

Table 30. Functional analysis of AIS in Kazakhstan

Function	Type of failure	Description of failure	Corresponding solution, proposed by experts
Function 1 - *Farmers' innovative activities*	Actors presence/capability	Low level of knowledge and awareness about CSA technologies among farmers	Conducting a wide promotion of CSA; Increasing awareness and knowledge about CSA
	Interactions presence/intensity		On the national level, to create a call center to provide farmers with information; Ministry of agriculture should provide the best technology replication through exchange visits of farmers implementing CSA
	Soft institutions presence/capacity	Low levels of farming culture	Implementation of educational programs
	Physical,	Lack of information	Financial and resources (land,

	knowledge and financial infrastructure quality	about CSA technologies; Weak technological base	machinery) support by international organisations; Development of system of incentives and insurance for CSA; Adapt the knowledge and international experience, successful practices of CSA for easy understanding by farmers; Rapid alert system for the producers and distribution of fast information on meteorological conditions, sowing dates and disaster probability
Function 2 - *Knowledge development*	Actors presence/capability	The lack of information about CSA technologies among scientists	Training and capacity building
	Interactions presence/intensity		Exchange visits; Cooperation with countries
	Knowledge infrastructure quality		Learn international experience on CSA and adapt it to the climatic zones of Kazakhstan; To choose pilot areas in all climatic zones of Kazakhstan for the replication of best practices; Improve access to data bases; Long-term weather forecasts for disaster risk reduction
Function 3 - *Knowledge dissemination*	Actors presence/capability		Creating extension services for introduction of new technologies; Training and capacity building
	Interactions presence/intensity	Lack of demonstration plots for dissemination of CSA technologies	Creation of demonstration plots on CSA technologies; On the national level, to create a call center to provide farmers with information; Transfer of knowledge to farmers: the publication of printed and video products, manuals and methodologies; Development of CSA technology package (soil conservation, organic farming,

			water-saving, soil protecting technology, etc.), its demonstration and implementation at the local level
	Hard institutions presence		Development of a national strategy for extension services
	Knowledge infrastructure presence/quality		Creation of database and information platforms on CSA for information exchange; Creation of info graphics, video-books, brochures etc.
Function 4 - *Guidance of the search*	Actors capabilities	Low awareness about CSA technologies among decision-makers	Permanent information and training program for all levels of the government
	Interactions presence/intensity	Lack of coordination between sectors (local, district, regional, scientific, etc.)	Creating a system of coordination for the implementation of CSA
	Hard institutions presence/capacity	Insufficient legal framework	Development of state sector program; Working on the legal acts and improvement of the regulatory framework; Analyze legal and policy documentations, perform necessary amendments for legal support of CSA process. Develop of recommendations, programs and strategies etc
	Interactions presence/intensity		Attracting investments for CSA implementation; Financial and resources (land, machinery) support by international organisations
	Financial infrastructure presence/quality		Development of system of incentives and insurance for CSA
Function 7 - *Creation of legitimacy*	Soft institutions presence	Low levels of farming culture	Implementation of educational programs for farmers

Turkmenistan

The main challenges posed by climate change in the agricultural subsectors in Turkmenistan, as identified through expert focus group discussion are the following:

- In crop subsector:
    - Reduced yields of wheat and cotton;
    - Reduced water resources due to water scarcity and droughts on the north of Turkmenistan;
    - Increased growth of pests (locust, plus 2 new pests) and wheat deseases in all zones;
    - Soil salinisation and deflation in all zones.
- In livestock subsector:
    - Decrease in pasture yields and fodder availability by 1.5%;
    - Lack of irrigation water for pastures in Central Karakum.

In order to address these challenges, the experts identified the following interventions as the highest priority:

- Crop diversification, including drought-resistant, disease-resistant crops (e.g. African millet); hardy, salt-resistant, drought-resistant wheat varieties in Nothern regions of the country;
- Management of water supply and irrigational systems: use of traditional technologies: wells (18-20 m), water collectors (basins) and sardobas in desert rangelands; protection

of drainage basins of mountain rivers in foothill and mountain areas; ridge sowing in Dashoguz, Lebap; no-till testing in Nothern Turkmenistan;

- Introduce methods to improve pasture yields and pasture management (seasonal, annual) in Central Karakum;
- Diseases and pests management: biological methods (cotton) in all regions and mechanical methods (locust) in foothill areas;
- Agroforestry: cultivation of pistachios and almonds in foothill and mountain areas;
- Support for development of gardening, slot sowing (in rainfed conditions) in foothill and mountain areas.

Meanwhile, discussing the CSA national programme in Turkmenistan, the following main objectives to be achieved were highlighted by the experts:

<u>On the national level:</u>

- Sustainably increase crop yields in drought conditions
- Increase the efficient use of water resources
    - Introduction of the concept of "river basin management" to the Water Code
    - Introduction of basin management at the local level
- Development and implementation of horticulture development program in drought conditions in Turkmenistan
- Introduction of valuable crops (pistachio, almonds)

- Improvement of legislation in the area of agriculture financing, of land and water relations

On the local (farmers') level:

- Increasing farmers' incomes by diversifying crops
- Introduction of a system of economic incentives for land preservation
- Increase crops' resistance to diseases
- Increase the capacity and knowledge of farmers in horticulture management

Experts consider lack of information and data on the state and availability of water and land resources to be a serious gap for establishing an evidence base to support CSA policies and programmes in Turkmenistan.

Among the government, donor and regional finance mechanisms to support the implementation of a CSA approach in Turkmenistan, the experts consider the most important those programmes, which provide economic incentives for farmers.

Among knowledge, research and extension services gaps to support implementation of CSA strategy in Turkmenistan, experts highlight:

- Need to integrate the necessary amendments into legal documents (Land and Water Codes);
- Need to enhance scientific and educational capacity;
- Need to improve information dissemination.

The following measures were proposed:

- Collect global, regional and national experience on CSA technologies;
- Create a database of scientists, specialists, experts, working in the field of CSA;
- Financial support to be derived partially from public budget, project and international investments;
- Increase State initiative for research works;
- Knowledge and research institutions of Turkmenistan should work in close cooperation with the scientists in the region.

Experts have summarized the main barriers for transition to a CSA in Turkmenistan as following:

- Imperfect legislation;
- Low institutional capacity for monitoring of the state of land resources;
- Imperfect and unstable system of extension services at the local, national and regional level;
- Lack of reliable water resources monitoring system (measuring appliances on the local, regional level).

And eventually, the following enabling environment interventions to overcome the existing barriers were suggested by experts taking part in the focus group discussions:

- Include CSA, water basin management, water use associations, agricultural services into the existing legislation framework in Turkmenistan.

Table 31. Functional analysis of AIS in Turkmenistan

Function	Type of failure	Description of failure	Corresponding solution, proposed by experts
Function 1 - *Farmers' innovative activities*	Actors presence/capability		Increase the capacity and knowledge of farmers in horticulture management
	Financial infrastructure presence/quality		Introduction of a system of economic incentives for land preservation
Function 2 - *Knowledge development*	Actors presence/capability	Low scientific capacity; Low institutional capacity for monitoring of the state of land resources	Increase State initiative for research works
	Interactions presence/intensity		Knowledge and research institutions of Turkmenistan should work in close cooperation with the scientists in the region
	Knowledge and physical infrastructure quality	Lack of information and data on the state and availability of water and land resources; Lack of reliable water resources monitoring system (measuring appliances on the local, regional level)	Collect global, regional and national experience on CSA technologies; Create a database of scientists, specialists, experts, working in the field of CSA
Function 3 - *Knowledge dissemination*	Actors presence/capability	Low educational capacity; Imperfect and unstable system of extension services at the local, national and regional level	
	Interactions presence/intensity	Poor information dissemination	
	Hard institutions presence/capacity	Imperfect legislation; Need to integrate the	Improvement of legislation in the area of agriculture financing, of land and

		necessary amendments into legal documents (Land and Water Codes)	water relations; Introduction of the concept of "river basin management" to the Water Code; Development and implementation of horticulture development program in drought conditions in Turkmenistan; Include CSA, water basin management, water use associations, agricultural services into the existing legislation framework in Turkmenistan
	Interactions presence/intensity		Financial support to be derived partially from project and international investments
	Hard institutions capacity		Improvement of legislation in the area of agriculture financing; Develop programmes which provide economic incentives for farmers
	Financial infrastructure presence/quality		Financial support to be derived partially from public budget

Tajikistan

The main challenges posed by climate change in the agricultural subsectors in Tajikistan, as identified through expert focus group discussion are the following:

- In crop subsector:
    - Reduced pasture productivity due to lack of moisture; negative impacts of droughts especially in rainfed areas on wheat and wheat-legume crops;
    - Negative impact of mudslides and floods on crop yields, fertile soils and infrastructure;
    - Reduced water resources due to water scarcity and droughts: drying out of small rivers and glaciers; irrigational conflicts on the village level;

    - Increased growth of pests and diseases (fungi diseases of grain crops) due to increased temperature and humidity; increased weed growth due to weakened crops;
    - Wind and water erosion.
- In livestock subsector:
    - Increased spread of livestock diseases and parasites due to temperature increase;
    - Reduced availability of drinking water for livestock in dry summers; and forage in winters, especially when followed by extended cold springs;
    - Livestock health and welfare decrease due to heat stress and lack of forage during droughts; cattle is more vulnerable due to smaller mobility for grazing.

In order to address these challenges, the experts identified the following interventions as the highest priority:

- Crop diversification: more adapted varieties of main crops and forages (drought-resistant and salt-resistant) are needed; strengthening of seed production;
- Filling the gap of water supply and irrigational equipment and technologies;
- Seasonal pasture rotation, introduction of SA and CSA best practice;
- Sustainable intensification: use mini agro-machinery capable of working on slopes; modernization of vaccines development for livestock; introduction of SLM and CSA practices;
- Prevention of soil erosion: provision of soil-conserving machinery and equipment;

- Agroforestry and silviculture development to provide additional supply with fodder, firewood and fruits;
- Alternative sources of electricity production: raising awareness, assistance in purchase;
- Registration of pesticides: inventory and destruction of old stocks in farms;
- Update of cartographic information on natural resources (vegetation, soil erosion, soil salinization etc.) using GIS technologies;
- Infrastructure development: modern equipment and laboratories for monitoring degradation processes in soils (salinization, erosion, agglomeration, compaction); climate data automatic weather stations required; seed and fruit nurseries for seedlings.
- Increasing the number of organizations providing rural advisory services and increasing their capacity.

Meanwhile, discussing the CSA national programme in Tajikistan, the following main objectives to be achieved were highlighted by the experts:

<u>On the national level:</u>

- Adoption of the National CSA Program in the Republic of Tajikistan;
- Development of rural advisory services.

<u>On the local (farmers') level:</u>

- Improve plant protection;
- Build farmers' capacity on the topic of CSA;
- Introduce alternative energy sources (solar panels, small hydrostations);

- Improve financial assistance to farmers;
- Improve market research system (consultant services) to explore, which crops are worth cultivating; which crops have good market demand etc;
- Establish a direct access to markets, giving farmers a choice whether selling themselves or through intermediaries;
- Explore storage opportunities next to newly started planting of large areas of gardens.

On the landscape level:

- Introduction of integrated watershed management, the use of PVA technologies;
- Reabilitation of pastures (severe degradation of pastures due to the large of number of cattle), increase the area under agroforestries, orchards and vineyards with forage crops in between the rows;
- Social protection in case of drought, flood, etc. - state support with food and things of 1st necessity (by state, from other states, international organizations);
- Raising awareness of public and experts in the field;
- Improving/developing rural advisory services - from state and non-state advisory centers.

Experts identified several gaps in analysis and data to establish an evidence base to support CSA policies and programmes in Tajikistan:

- Climatic data do not cover the entire territory of the republic, and not in the appropriate for agriculture scale;

- Lack of information from the financial accounting system (from the Statistics Committee) on the level of households (currently accounting of income and expenditure of small households is not conducted; Statistics Committee currently works on the level of households only for the area of land and crops grown/productivity, but not for incomes);
- Absence of information on the market (product prices, demand for certain crops);
- Lack of information on comparative vulnerability of areas in Tajikistan and their proneness to drought, salinity, frost (Hydromet, institutes of TAAS); vulnerability and proneness to the outbreaks of plant and animal diseases (Ministry of Agriculture and its affiliated companies).

Experts proposed several improvements needed to ensure that the knowledge/ evidence base is created, shared and used effectively to support CSA policies and programmes in Tajikistan:

- Statistics committee should request the government to start accounting for households. It was decided to start from 2017, but for the widespread introduction financial support for the committee is necessary;
- It is necessary to integrate CSA and SLM into the curriculum and of the Tajik Agrarian University and Tajik State University;
- Increase the number of centers of public advisory services (currently available advisory services are not free) or increase the capacity of local experts (at the level of district and jamoat) working with farmers on the daily basis.

When discussing the government, donor and regional finance mechanisms to support the implementation of a CSA approach in Tajikistan, the experts expressed the need for donor's

help in capacity building in all areas related to agriculture, technically and by exchange of experience in the region (in water resources management at the regional level, in regional climate risk management). As for the governmental financial support, experts consider it less important, instead they suggested that the government should improve the legislative mechanisms to encourage farmers who use CSA.

As for the specific gaps and obstacles for coordination at local level to support CSA, experts specified the following:

- Laws and policies exist, but one of the main obstacles of CSA implementation is lack of by-laws;
- The is a need to provide climate information to farmers, to develop capacity of farmers, extension agents, experts (i.e. on mapping of soils); to share information, improve knowledge on legislation and best practices;
- It is important to prioritize rainfed systems (pastures in particular) in order to increase productivity (food and fodder production) and release stress from winter pastures (most representative of the region);
- No particular targeting of the beneficiaries is currently conducted.

Experts have summarized the main barriers for transition to a CSA in Tajikistan as following:

- Imperfect legal system;
- Lack of institutional capacity;
- Lack of cross-sectoral coordination in the field of SLM and CSA;
- No access to high-quality seeds;

- Lack of access to meteorological data, low capacity of experts meteorologists;
- Unavailability of (free) advisory centers for farmers.

And eventually, the following enabling environment interventions to overcome the existing barriers were suggested by experts taking part in the focus group discussions:

- Increase capacity for seed selection;
- There is a need for national platform with all information related to CSA - on exhibitions, farm schools, on seed prices and agricultural products prices, any projects working in the field of SLM and CSA.

Table 32. Functional analysis of AIS in Tajikistan

Function	Type of failure	Description of failure	Corresponding solution, proposed by experts
Function 1 - *Farmers' innovative activities*	Actors presence/capability		Build farmers' capacity on the topic of CSA
	Interactions presence/intensity		Provide climate information to farmers
	Hard institutions presence/capacity		The government should improve the legislative mechanisms to encourage farmers who use CSA
	Physical and financial infrastructure presence/quality	Lack of water supply and irrigational equipment and technologies	Provision of soil-conserving machinery and equipment; Introduce alternative energy sources (solar panels, small hydrostations); Explore storage opportunities next to newly started planting of large areas of gardens; Improve financial assistance to farmers
Function 2 - *Knowledge development*	Actors presence/capability	Lack of institutional capacity; Low capacity of	Raising awareness of experts in the field; develop capacity of experts (i.e. on

		experts meteorologists	mapping of soils); Increase experts' capacity for seed selection
	Interactions presence/intensity	Lack of access to meteorological data	
	Knowledge and physical infrastructure presence/quality	Climatic data do not cover the entire territory of the republic, and not in the appropriate for agriculture scale; Lack of information on comparative vulnerability of areas in Tajikistan and their proneness to drought, salinity, frost (Hydromet, institutes of TAAS); vulnerability and proneness to the outbreaks of plant and animal diseases (Ministry of Agriculture and its affiliated companies);	Update cartographic information on natural resources (vegetation, soil erosion, soil salinization etc.) using GIS technologies Providing modern equipment and laboratories for monitoring degradation processes in soils (salinization, erosion, agglomeration, compaction); climate data automatic weather stations required; seed and fruit nurseries for seedlings
Function 3 - *Knowledge dissemination*	Actors presence/capability	Lack of institutional capacity; Unavailability of (free) advisory centers for farmers	Increase the number of centers of public advisory services or increase the capacity of local experts (at the level of district and jamoat) working with farmers on the daily basis; Develop capacity of extension agents
	Interactions presence/intensity		Share information on best practices
	Knowledge and financial infrastructure presence/quality	Currently available advisory services are not free	Integrate CSA and SLM into the curriculum and of the Tajik Agrarian University and Tajik State University; There is a need for national platform with all information related to CSA - on exhibitions, farm schools, on seed prices and agricultural products prices, any

			projects working in the field of SLM and CSA.
	Hard institutions presence/capacity	Imperfect legal system; Laws and policies exist, but one of the main obstacles of CSA implementation is lack of by-laws	Adoption of the National CSA Program in the Republic of Tajikistan; The government should improve the legislative mechanisms to encourage farmers who use CSA
	Knowledge infrastructure presence/quality		Improve knowledge on legislation
	Interactions presence/intensity	No access to high-quality seeds	Establish a direct access to markets, giving farmers a choice whether selling themselves or through intermediaries
	Knowledge and physical infrastructure presence/quality	Absence of information on the market (product prices, demand for certain crops)	Improve market research system (consultant services) to explore, which crops are worth cultivating; which crops have good market demand etc; Establish a direct access to markets
	Interactions presence/intensity	No particular targeting of the beneficiaries is currently conducted	Social protection in case of drought, flood, etc. (from other states, international organizations); Donor's help in capacity building in all areas related to agriculture, technically and by exchange of experience in the region (in water resources management at the regional level, in regional climate risk management).
	Hard institutions presence/capacity		Improve financial assistance to farmers; Social protection in case of drought, flood, etc. - state support with food and things of 1st necessity
	Knowledge infrastructure presence/quality	Lack of information from the financial accounting system (from the Statistics Committee) on the level of households	Statistics committee should request the government to start accounting for households. It was decided to start from 2017, but for the widespread introduction financial support for the committee is necessary

		(currently accounting of income and expenditure of small households is not conducted; Statistics Committee currently works on the level of households only for the area of land and crops grown/productivity, but not for incomes)	

Chapter conclusions

Following the analysis of the research results in 4 countries of Central Asia, covering the data collected through expert focus group discussions, online questionnaire and several short clarifying interviews, not including diagnostic questions, several observations were made:

- Many recommendations are too generic, not specifying any concrete actions (e.g. "improve information dissemination");
- No clear picture and vision were expressed about how they will be implemented, apart through some small scale international projects;
- Measures proposed are not connected to each other, belonging under different responsibilities;
- No prioritisation of measures was made by the experts;
- The number of recommendations provided by experts substantially exceeds the number of identified barriers;

- Very often the recommendations don't match the barriers, targeting either non-existent systemic failure or the wrong structural element. But most often, the important barriers are left by experts without attention.

Critical analysis of the abovementioned observations allows to see the following limitations of this type of analysis:

- The lack of information doesn't allow to identify root causes of the systemic failures. For instance, "lack of funding for agricultural research" doesn't say much about the original reason - is it because of lack of financial resources in the country itself (financial infrastructure quality), because of the absence of policies stimulating investment in research (hard institutions presence) or because of the lack of central initiative/understanding of the importance of the research by the government (actors capacities). This makes the researcher unable to build a causal relations scheme and prioritise solutions. The same goes for solutions proposed by experts, e.g. "enabling access to CSA technologies": it doesn't provide clear information on how it can be done - through markets (F5, infrastructure failure), through access to credit (F6, hard institutions failure), through governmental strategies (F4, hard institutions failure) or elsehow?;
- The mismatch of proposed solutions and barriers identified, gives food to think that experts often make their suggestion only because they think it is "a good thing to do" or because of their personal interest (to receive financing for that purpose), and not because it is a real solution for the existing problem;

- Failure of experts to prioritize their recommendations at the end gives a long list of disrupted actions belonging under different responsibilities, which would be difficult to coordinate and implement, even if unlimited funding was available;
- Obviously, experts in Central Asia are oriented on AKIS type of innovation upscaling focusing on research, learning and information dissemination, largely underestimating other functions as F5 (almost no attention was given to markets) and F7 (creation of legitimacy). For instance, only 2 focus groups revealed market function failures, and only one group highlighted low level of farming culture, which is a serious obstacle to creation of legitimacy.
- Insiders (national experts) not always see the best solution – they might be biased, have narrow area of expertise, insufficient analytical capacities or simply don't have all the information needed to make the right conclusions. That is why there is a need of an outsider's (researcher's) look, who, having gathered all the data and opinions, can track the real problems in the system by applying critical thinking and effective analytical frameworks.

All mentioned limitations of the analysis conducted for these 4 countries, which results are far less informative and, most important, not allowing to create a workable and effective integrated policy instrument, provide much food for criticisms of the method, used by many international organisations for designing their projects.

Compared to that, deep and structured analysis with the help of the analytical framework, used by the Author for the analysis of AIS in Kyrgyzstan, based on the rich triangulated data from multiple sources, including farmers, provided much better opportunity to see the clear picture of the existing problems and their causes, and to construct an effective tool to solve them.

Conclusions

This final chapter summarizes the key findings of the study, highlighting the way the objectives were fulfilled; underlines the theory added value of the research; explains the limitations and outlines the way forward for future scientific work on the topic.

The study has successfully achieved all its 4 objectives:

- ✓ To explore the situation in the countries of CA regarding adoption of CSA practices, constraints to it, and existing and potential interventions for upscaling these practices;
- ✓ To develop analytical framework for the in-depth analysis, combining the advantages of existing frameworks in the technological innovations theory and suitable for the analysis of Agricultural Innovation Systems, at the same time free of limitations of the existing AIS analytical frameworks;
- ✓ To use the developed analytical framework to analyse malfunctioning and systemic failures in the Agricultural Innovation System for CSA in Kyrgyzstan, and to develop an integrated systemic policy instrument to overcome these problems;
- ✓ In Tajikistan, Turkmenistan, Kazakhstan and Uzbekistan – to perform the analysis using simplified framework, compare the results and make a conclusion about the practical and theory added value of the research.

Objective 1 was achieved in Chapter "Background information" through in-depth review of scientific articles, project reports, policy and legal documents and official Internet sources.

Objective 2 was addressed in chapter "Theoretical framework" and sub-chapter "Construction procedure of the holistic systemic instrument" (see also "Theory added value" below).

Objective 3 was fulfilled in chapter "Results and analysis of AIS in Kyrgyzstan", which illustrates the in-depth analysis of agricultural innovation system in the Kyrgyz Republic using the developed framework; and chapter "Recommendations", which suggests an integrated policy instrument as a solution.

It was identified that the main constraints to CSA adoption by Kyrgyz farmers are: lack of central initiative and willingness to support CSA; underdeveloped interactions with potential donors of CSA projects; low capacity of international actors to design the projects (including, identifying applicable CSA methods, training extension, performing evaluation and upscaling). The second level of importance gain the "infrastructural" constraints: poor financial infrastructure (scarce public funding of agricultural research and knowledge dissemination); low quality of knowledge infrastructure (research, education and knowledge dissemination on CSA); poor quality of physical infrastructure and inefficient legislative/policy framework for CSA.

The proposed solution includes creation of the system of "agro-clusters" in Kyrgyzstan, as a center-led initiative and a large transformative project, which would simultaneously address identified obstacles and enable rapid upscaling of CSA in the country.

Finally, Objective 4 is addressed in chapter "Results for Uzbekistan, Kazakhstan, Tajikistan, Turkmenistan and discussion". Such limitations of the study, as safety considerations and limited time and financial resources, didn't allow to conduct in-depth interviews with farmers and experts in other CA countries, apart from Kyrgyzstan. Therefore, only partial brief functional analysis was performed in this study for Uzbekistan, Kazakhstan, Tajikistan and Turkmenistan. For this purpose the simplified framework was applied, and conclusions were

made about its comparative weaknesses compared to the developed framework, based on the achieved results.

It is crucial that in future research an in-depth analysis with the help of the developed in this study improved analytical framework is performed in Uzbekistan, Kazakhstan, Tajikistan and Turkmenistan too. The developed framework would in this case receive additional testing, and the integrated policy instruments are to be constructed for these countries.

Theory added value

Achieving the objectives of this study required application of the comprehensive analytical framework for the analysis of agricultural innovation systems, which would allow to identify existing constraints in the system, that hamper the dissemination of CSA practices, as well as to develop an effective integrated policy instrument for addressing these constraints.

Such framework was developed by the Author of this research, after thorough analysis of the advantages and drawbacks of the analytical tools currently existing in the theoretical body of the innovation systems theory in both "general" and "agricultural" streams. As a result, Wiezorek&Hekkert technological innovations systems framework was selected as the base for a new framework.

Advantages of the combined functional-structural analysis used by Wiezorek and Hekkert; simplicity, obvious links between elements and its effects on the performance of the system and respectively agricultural problems, determined this choice.

However, the framework needed several substantial improvements for both adapting it for the use in agricultural analysis, and for improving procedures in the framework itself to achieve

better quality of the analysis results, to increase convenience of its application, and to ensure the effectiveness of the selected/constructed policy instruments.

The following improvements were made:

- The methodology was enhanced by combining outsiders' (researchers, experts) and insiders' (farmers) opinions for both analysing the functional performance of the AIS and identifying problems in it, and for the selection of solutions. Interrogating farmers regarding whether application of a certain mechanism/incentive would stimulate their interest to try/adopt/continuously use a CSA practice makes a crucial part of the methodological process. It is explained by the fact that insiders might see the situation "from inside" more clearly, and express their preferences for the instruments to be applied. For instance, it was revealed that "cooperatives as usual" widely promoted by the experts as a workable solution, often turn out to be ineffective because farmers oppose this idea.
- All groups of stakeholders (actors) were included into situation analysis - interviews were conducted with ministry officials, practitioners from state agencies and committees, local administrations, national experts, research institutions and academia, international experts, NGOs, extension services, micro-financial organisations, large agricultural enterprises, agricultural cooperatives, family farmers.
- Various methods of data collection were combined (interviews, focus group discussions, online questionnaire, participant observation, field visits, legislation and policy analysis) to ensure the highest triangulation of data.

- A comprehensive set of diagnostic questions was developed, which is appropriate to be applied for the analysis of any other agricultural innovation system.
- Policy/legislation analysis was added to secondary data analysis. This is an important adjustment, because often the respondents don't have enough deep knowledge on the existing legislation and policy, or might be unaware of its latest updates. Comparing information is very useful too - it helps not only to get the full picture, but also to analyse gaps in the legal/policy framework, state of its implementation and enforcement by the government, effectiveness in achieving the stated objectives, level of awareness of stakeholders about the policy etc.
- Systemic problem goals, proposed by Wieczorek and Hekkert 2011, are too generic, and don't help identify specific solutions to concrete problems. Suggestion was made to rather look into each concrete structural cause and analyse ways to solve the problem.
- The procedure of how to construct the integrated systemic instrument, proposed by Wieczorek and Hekkert 2011, was substantially improved. The vague and unclear suggestion to select the instruments, which would "mutually reinforce each other" sounds logical, but doesn't give even a simple explanation of the steps to be followed to find such instruments and how to understand that they would enhance each others' effects. This study proposed a step-by-step procedure, which helps identify suitable instruments and to build an integrated systemic tool from the prioritised instruments, that cause the "avalanche effect". For this, at first the mapping of blocking mechanisms should be performed, through building causal chains/diagram to identify the "grass root" reasons for system malfunctioning, which should be addressed as a priority.

- It is suggested that the list of possible systemic instruments to be applied for the particular AIS should include 1) 1t priority elements – the instruments, that have already successfully been used in the country to solve the existing systemic problem and helped gain good result on the limited area/location; 2d priority - those successfully used in the neighboring countries with common history, traditions and similar context; 3d priority - successfully used in other countries to target the similar problems, and potentially applicable to the country context.
- Finally, in comparison to earlier analytical frameworks, the majority of which are cumbersome and tend to duplicate the steps, the new analytical framework is simple in application, logical, and effective in developing a comprehensive and workable policy solution.

Therefore, the improved framework, built on advantages of existing analytical tools, allows to produce a richer and more comprehensive analysis, and facilitates the procedure of constructing a more holistic and effective integrated policy instrument.

Annex A – Description of some climate smart practices used in the Kyrgyz Republic

Irrigation using polyethylene bottles

Description of the technology:

This irrigation method is considered to be a primitive type of drip irrigation. It is frequently used in Kyrgyzstan to irrigate young tree seedlings.

The bottom of the 5-liter polyethylene bottle is cut off, the upper part is punctured several times on the cover or on the side. The bottle is then hung up above the plant on a hook, and filled with water, which is usually sufficient to water the plant during 6 to 7 days.

The technology can be used to improve the state of soil by preventing soil water erosion and enhance moisture content of the soil.

Advantages	Trade-offs
• helps increase crop growth and yield in rainfed conditions; • saves irrigational water; • prevents erosion, improves soil quality; • allows to cultivate trees on the previously unused lands; • rather cheap materials	• manual refilling of water in bottles and control of water level; • labor-consuming installation process; • necessity of recycling the plastic material at the end of the vegetative period

Contour irrigation

Description of the technology:

The land is first marked with contour lines using geodetic tools, then the contour furrows are cut with a small angle to these lines. A plastic tray with holes on the bottom are set in the place of a highest slope, which serves for water distribution into each furrow. During irrigation water is supplied into the tray, and from there through each hole into the furrows. Duration on the irrigation is regulated according to the crop needs by opening and closing flat gate between the tray and the water source.

Can successfully be applied on the sloping areas with slope of more than 25%.

Advantages	Trade-offs
• Slows down the speed of water flowing in through furrows and thus helps decrease the soil erosion up to 70%; • Allows to use steep slopes for cultivation of irrigated crops	• Labor intensive cutting of furrows along the contour lines; • Cost of trays

Irrigation of crops sown in furrows

Description of the technology:

In this practice the furrows are cut simultaneously with crop sowing. For this, modified seeder machinery is used, where some of the plows are replaced with furrow-cutters. Alternatively, it is possible to use standard furrow-cutting machinery and seeder, which should pass one after another by sowing seeds into the slopes of the cut furrows.

Due to tighter contact of seeds with soil, the former germinate faster. Moreover, developing plant roots better hold the soil around the furrow, which helps decrease the speed of water during irrigation and considerably reduce erosion.

Successfully applied for wheat, alfalfa, herbs and narrow-row crops.

Advantages	Trade-offs
• Allows to cultivate crops on slopes up to 0,1-0,15; • Accelerates seeds germination; • Decreases (or prevents) erosion; • Allows to use up to 30% less water; • Helps more uniform (90-95%) distribution of moisture in the the soil	• Cost, labor and skills are required to modify the seeder; • Previous leveling of soil is needed

Cultivation of melons (watermelon) under plastic films

Description of the technology:

About 1 m wide stripes of transparent polyethylene film are layered over the furrows above the seedlings. On the outer side of the furrow the film is attached with soil, which should not touch the plants. After that 1,5 m acres are installed over the furrows at every 2 m and covered with the 2d layer of the film, which again is attached to the ground with the help of soil.

After several days, when the seedling become bigger and approach the 1t layer of the film, the film frame (2d layer) is lifted from the side and the 1t film is cut to let the plant out, and some soil it put along the cut. 1t film then serves as mulch. The 2d layer film is then returned into its initial position on the arc frame. In cases when temperature inside the film tunnel gets higher

then +28°C, it might be ventilated by lifting the 2d film on the tunnel end. When the outside temperature reaches stable 20°C, the film should be removed.

Advantages	Trade-offs
• 1,5-2 times increased soil heat creates an optimum temperature for growth of seedlings, protecting them from frosts • Vegetation time is reduced by 12-15 days; • 70-80% less water loss through evaporation; • Twice less number of irrigations needed; • 100% increase of yield; • Early harvesting allows to sell the produce at higher price; • Cheap materials	• Previous ground leveling is required; • Need to recycle the removed film

Cultivation of drought-resistant oilseed and forage crop - safflower

Description of the technology:

Safflower is a heat and drought-resistant crop. It is planted 4-5 cm deep, with interval 45-60 cm. Seeds germinate in 1-1.5 weeks, and can withstand frost (-3°C to -6°C). Flowering occurs 2,5 months later and lasts about a month. Seeds mature during 1,5 months. After full dry out of plants, safflower is harvested by combine harvesters (manual harvesting is impossible because of spikes).

Safflower is tolerant to diseases and pests, so doesn't require application of pesticides. It also doesn't need fertilization with mineral fertilizers. The crop is easy to grow, but crop rotation with winter crops, such as maize, is important.

Safflower is a very profitable crop. Apart from high yield of seeds, which contain 30-45% of oil, farmers can use cake left after oil extraction and top thin twigs to feed livestock; high-protein seeds can be fed to poultry; lower thicker stems are used as fuel; the flower petals are used to produce dyes and in food production/cooking for the same purposes as saffron. Safflower is also a honey plant, and is good for beekeeping.

Advantages	Trade-offs
• Adapted to grow in drought conditions without irrigation; • Low cost of production; • Very profitable and multi-purpose, helps increase income of farmers; • Easy to grow; • Don't require application of pesticides and mineral fertilizers; • Spiky plants don't need to be fenced from livestock.	• Impossible to grow in waterlogged soils; • Because of spikes, can only be harvested with a combine harvester.

Growing crops on shallow rocky soils

Description of the technology:

2 weeks before planting, the 1-1.5 m holes 50-80 cm deep are prepared. The infertile rocky land is removed, and the holes are filled with a part of mixture of fertile soil and compost. After 2 weeks, when the soil is settled down, the seedling are put into the holes, the roots are well

distributed, and the remaining space is filled with the rest of the fertile soil mixture, which should be gently pressed to make it more compact and to avoid large spaces between the roots and the soil. Then the plants are watered, after that a little depression is made around the plants with pouring additional 2 buckets of water into it. The later watering is made according to the schedule with the help of drip irrigation (preferably).

This practice is suitable for cultivation of vegetable crops, but mostly used for growing fruit trees.

Advantages	Trade-offs
• Allows to use infertile stony/sandy unused land; • Enables to obtain stable high crop yields even in lack of irrigation water; • On slopes, tree roots help holding soil and decrease erosion	• Costs and labour to dig the holes and replace the rocky soil

Growing sainfoin in mountain farming

Description of the technology:

In mountain conditions a perennial grass, sainfoin, is grown in crop rotation with barley in a 5-year cycle (1 year – fallow, 2 year – barley, and 3,4,5 years – sainfoin).

Sainfoin can be cultivated as high as 3400 m above sea level, produces more than 300 kg/ha of biomass, and due to fixating nitrogen from the atmosphere by root bacteria helps restore soil fertility.

Sainfoin is also used in beekeeping, allowing to produce up to 150 kg/ha of honey per season.

Advantages	Trade-offs
• Very productive; • Helps restore soil fertility; • Increases incomes of farmers, allowing to sell seeds, hay and honey; • As cover crop decreases erosion; • May be cultivated at high altitudes in mountain farming	• Certified seeds are rather expensive; • Need to keep fallow for 1 year is unprofitable; • Special knowledge is needed for seed production.

Annex B – Results of the online questionnaire

Question 1: What do you consider as the main socio-economic constraints for transitioning to more sustainable, resilient and efficient production systems?

1. Poverty

2. Limited access to land/land tenure related

3. Lack of access to input market

4. Lack of access to output market

5. Limited access to credit, insurance etc.

6. Lack or limited access to information related to socio-economic mechanisms (credit, insurance, etc.)

7. Lack of limited access to extension services

8. Gender inequality

9. Lack or inadequate social protection schemes including insurance, social safety nets

10. Limited capacity to absorb knowledge & information as a result of limited years of formal education

11. Limited availability of labour, due to e.g. (youth) migration

The obtained responses were processed and the corresponding percentages of choices were calculated for each constraint. Based on this, graphs were built for each country.

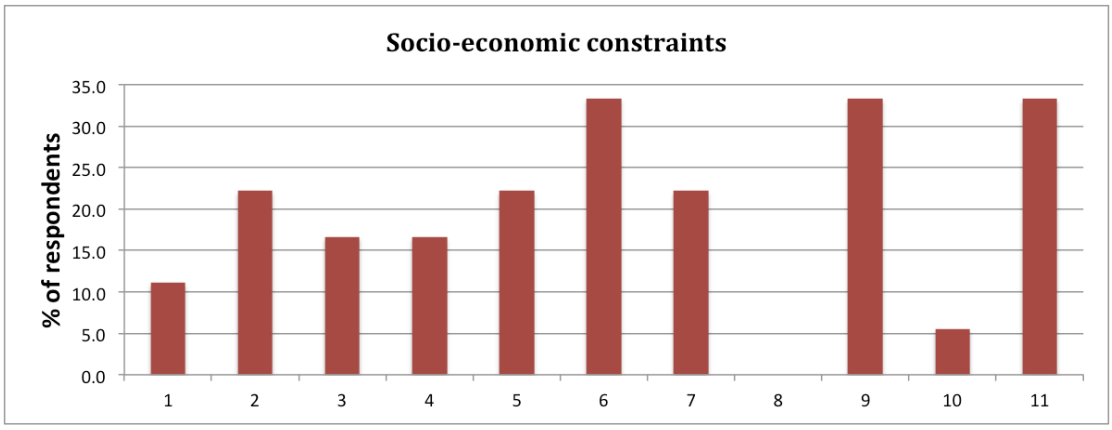


Figure 20. Socio-economic constraints in Kazakhstan according to the survey

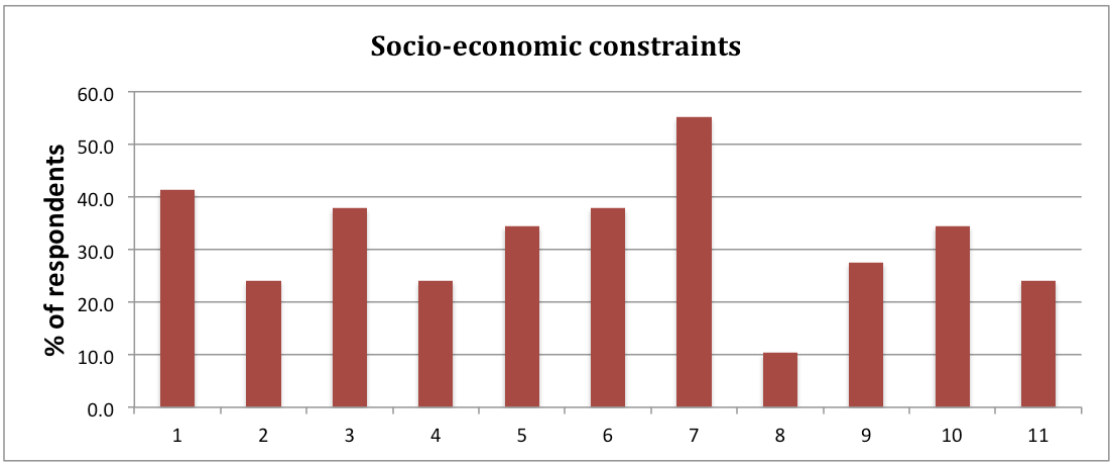


Figure 21. Socio-economic constraints in Kyrgyzstan according to the survey

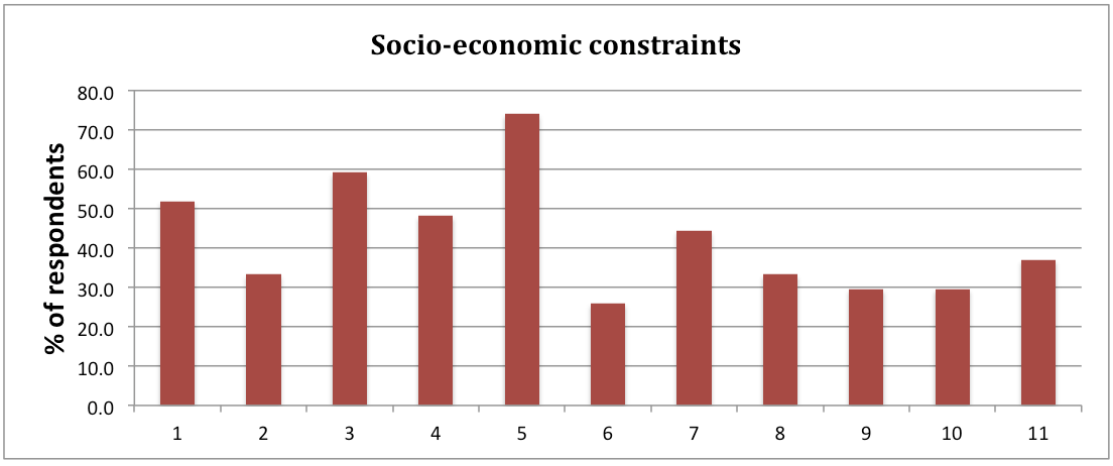


Figure 22. Socio-economic constraints in Tajikistan according to the survey

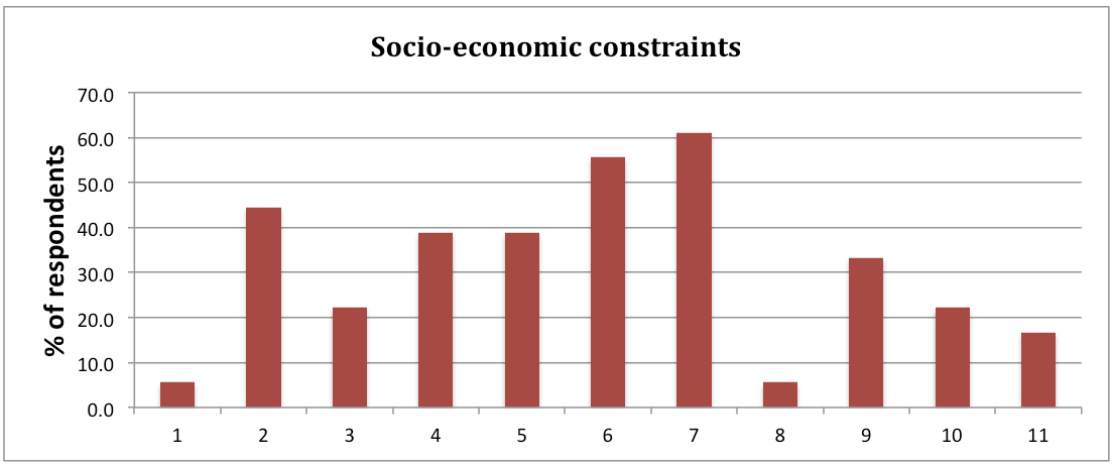


Figure 23. Socio-economic constraints in Uzbekistan according to the survey

Question 2: What do you consider as the main policy and institutional constraints for transitioning to more sustainable, resilient and efficient production?

1. Lack of state management/legislation in agricultural production and decision making at all levels.

2. Absence of relevant laws, policies, plans, strategies to enable improved planning.

3. Lack or limited institutional cooperation, collaboration and communication among relevant stakeholders to ensure effective and efficient implementation.

4. Lack or limited human resources and capacity to conduct research and absorb knowledge and information.

5. Lack or limited institutional planning capacity

6. Lack or limited community organization and involvement with regard to agriculture

7. Lack or limited available mechanisms for knowledge sharing and capacity building to transfer knowledge to farmers, extension services and other related entities

The obtained responses were processed and the corresponding percentages of choices were calculated for each constraint. Based on this, graphs were built for each country.

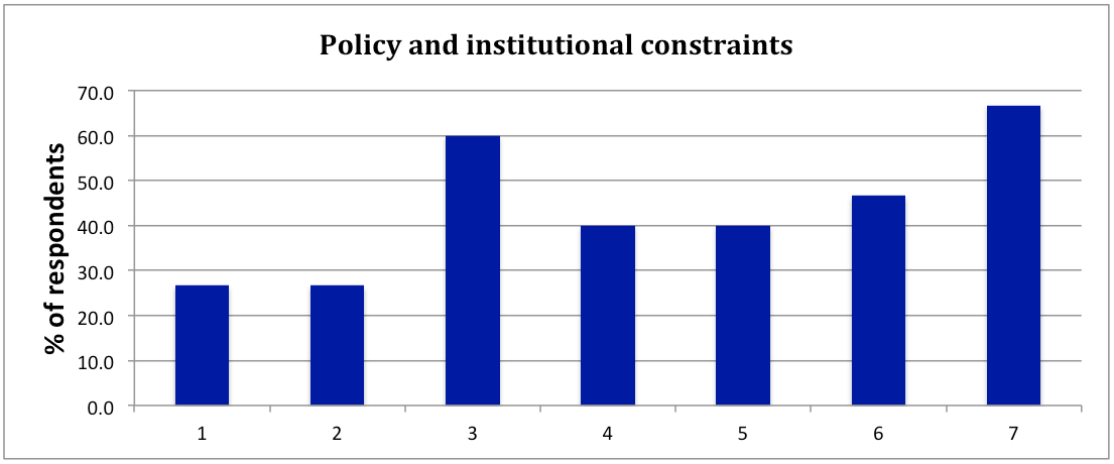


Figure 24. Policy and institutional constraints in Kazakhstan according to the survey

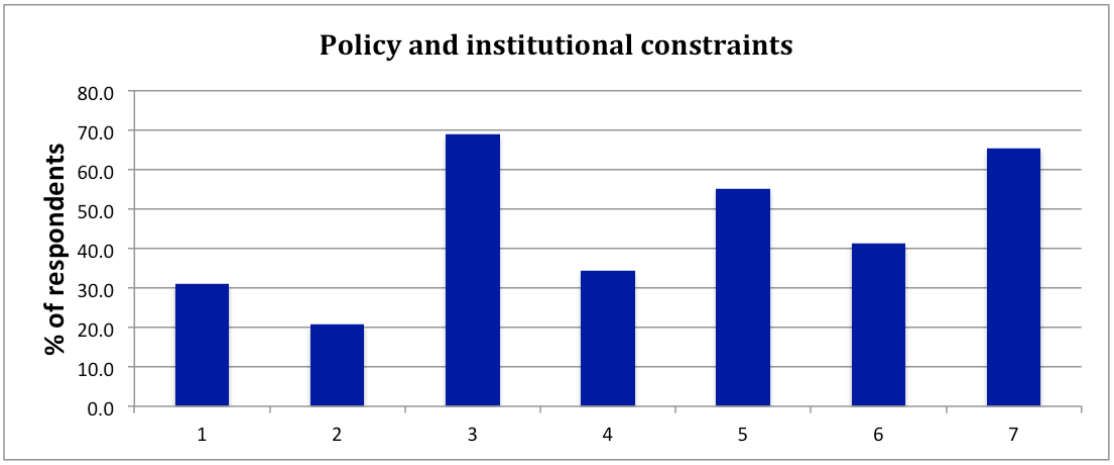


Figure 25. Policy and institutional constraints in Kyrgyzstan according to the survey

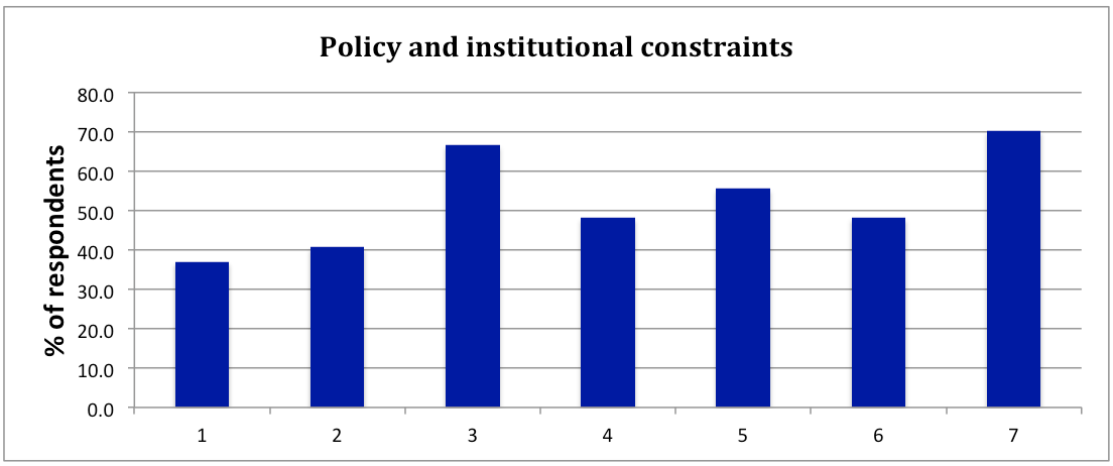


Figure 26. Policy and institutional constraints in Tajikistan according to the survey

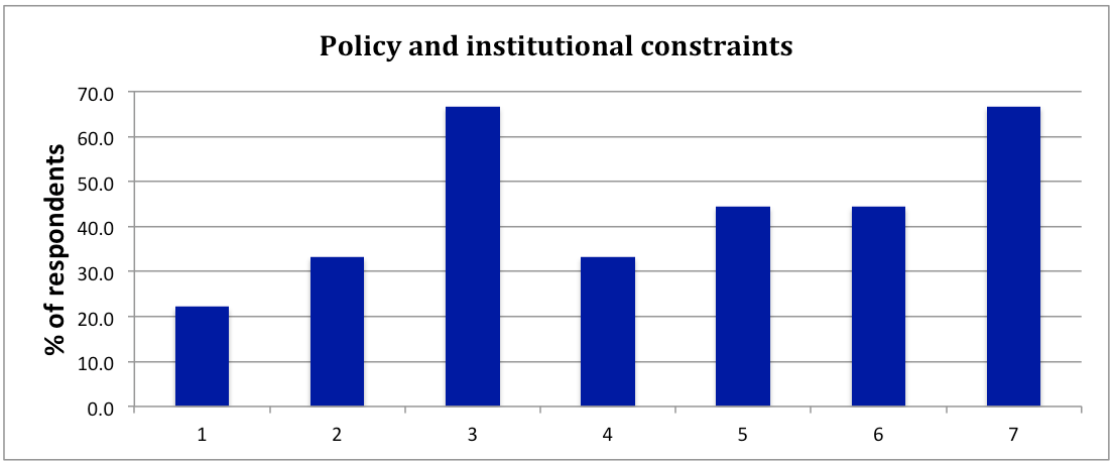


Figure 27. Policy and institutional constraints in Uzbekistan according to the survey

Question 3: Based on the main constraints identified, please select 4 policy and institutional support mechanisms needed to overcome barriers and allow for rural development transitions.

1. Identify key stakeholders in setting up national CSA programmes

2. Formulate cross-sectoral policies to support CSA

3. Decision tools for prioritizing CSA investment options

4. Increasing investment in research capacity on CSA

5. Analysis of the enabling environment/barriers to adoption

6. Building stronger links between agriculture & other sectors

7. Strengthening farmers' inclusion and leadership in CSA knowledge systems

8. Providing better links and support for market access to farmers and shortening the value chain

9. Providing incentives for private sector leadership on CSA innovation

10. Individual capacity development and technical assistance for the adoption of new practices / technologies

11. Organizational / institutional capacity development to improve coordination between CSA relevant stakeholders

12. Support performance of cooperatives / producer organizations to further adoption / uptake of CSA practices

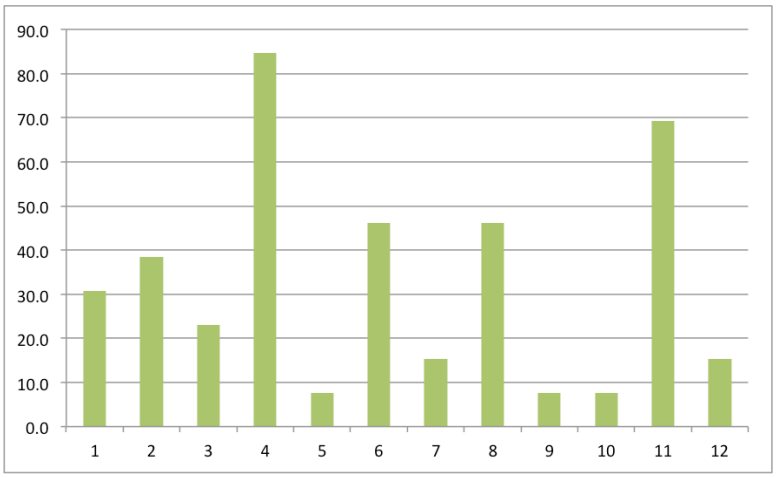


Figure 28. Mechanisms for transition to CSA in Kazakhstan according to the survey

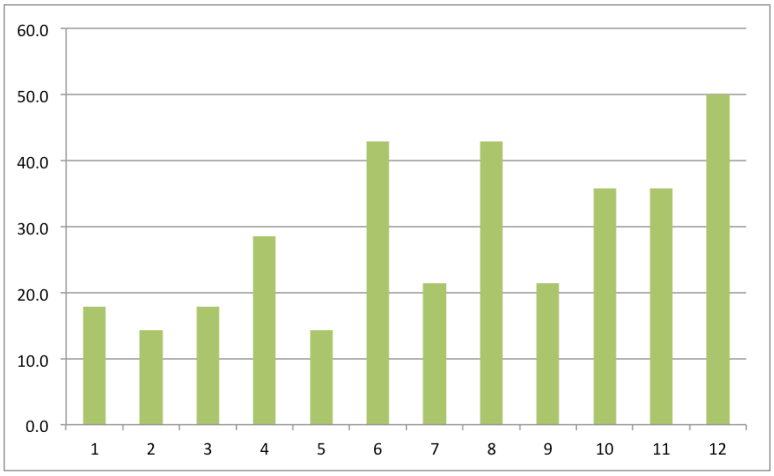


Figure 29. Mechanisms for transition to CSA in Kyrgyzstan according to the survey

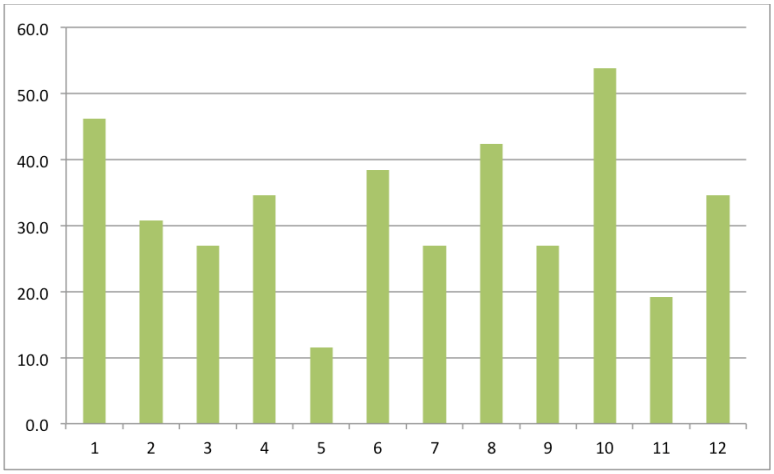


Figure 30. Mechanisms for transition to CSA in Tajikistan according to the survey

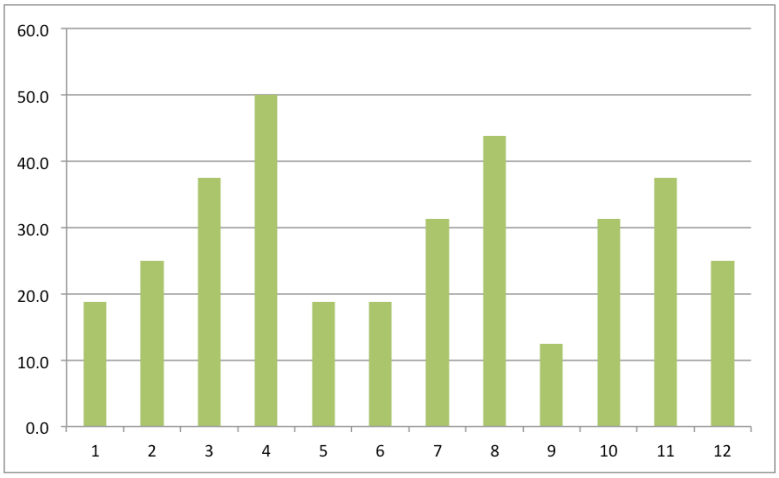


Figure 31. Mechanisms for transition to CSA in Uzbekistan according to the survey

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