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EVALUATION OF LAND AND WATER REFORMS AND COOPERATION AMONG FARMERS: THE CASE OF SAMARKAND PROVINCE, UZBEKISTAN

08.00.04-Agricultural economics

PhD (Doctor of Philosophy) dissertation
ABSTRACT

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Doctoral dissertation has been prepared at Samarkand branch of Tashkent State University of Economics and Tashkent institute of irrigation and agricultural mechanization engineers.

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INTRODUCTION (Abstract of PhD thesis)

Problem background. Land is the main source on providing requirements of world population for food and fibre. Land use efficiency is thus the main issue and depends on the progress land reforms. The experience of some developing countries showed that agrarian reforms varied across countries. For example, China implemented land and water reforms starting from 1978. Such reforms included the adoption of new land leasehold system, i.e. land-use rights, land tax and user fees, land rights protection, land administration, and regulations over land markets[1]. As part of water reforms in Northern China, water users associations (WUAs) were established in 1995-2004[2]. In 1990s. Central and Eastern European countries such as Albania, Slovenia, Poland implemented land privatization reforms[3].

Globally, the distribution of agricultural land is expanding due to a variety of historical, political, institutional, and social factors, including optimization, transaction costs in the land market, urbanization policy[4]. Increasing water scarcity, land degradation, and desertification due to the global climate change require that the scarce agricultural resources are used efficiently. Furthermore, the pandemic caused by COVID-19 virus affects agricultural production. On the other side, food demand and food security are greatly affected due to mobility restrictions, reduced purchasing power. Particularly, a greater impact was on most vulnerable population groups[5]. In this regard, evaluation of land and water reforms, the most critical agricultural production factors, is essential.

Agrarian reforms are particularly pronounced in transition economies. Uzbekistan presents an interesting case as the reforms covered both land (individual farms) and water (WUAs) sectors. Uzbekistan has been actively restructuring its agricultural sector, with the government has maintained strong involvement in agricultural decisions of cotton producers at district, regional and national levels. At the same time, poor rural infrastructure, high production costs such as machinery, fertilizer, seeds, have negative impact on farm activity. In this regards, cooperation among farmers may be useful to overcome these issues. Furthermore, farm cooperation among water user is necessary to collectively overcome the problems of growing water scarcity and uncertainty. Land and water use is challenged by various factors such as central coordination of agricultural production and water use, absence

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[1] Ding, C. (2003). Land policy reform in China: assessment and prospects. Land use policy, 20(2), 109-120.

[2] Wang, J., Huang, J., Zhang, L., Huang, Q., & Rozelle, S. (2010). Water Governance and Water Use Efficiency: The Five Principles of WUA Management and Performance in China1. JAWRA Journal of the American Water Resources Association, 46(4), 665-685.

[3] Deininger, K. (2002). Agrarian reforms in Eastern European countries: lessons from international experience. *Journal of International Development*, *14*(7), 987-1003.

[4] Latruffe, L., & Piet, L. (2014). Does land fragmentation affect farm performance? A case study from Brittany, France. *Agricultural systems*, *129*, 68-80.

[5] Siche, R. (2020). What is the impact of COVID-19 disease on agriculture?. Scientia Agropecuaria, 11(1), 3-6.

of land ownership, nonlinear process of farm restructuring, top-down water management (when water users are not involved in decisions over water allocation plans), non-compliance to water turns and unequal distribution, farmers' psychological resistance to cooperate, lack of knowledge on organization of cooperation with other farmers. Most farmers understand collective action, or cooperation, as a component of old kolkhoz system. Every farmer wants to maximize his/her benefits without taking into account the needs of other farmers. Farmers do not have any economic interests to save water and take into account the water needs of other farmers. In this regards, agrarian reforms can be useful to solve these social dilemma. Despite its importance at the national scale, there is still only a handful studies in Uzbekistan which address this problem using empirical investigation methods.

This study addresses the problems mentioned in the recent official documents such as the Decree of the President of the Republic of Uzbekistan dated February 7, 2017 "On the Strategy for the Further Development of the Republic of Uzbekistan", Presidential Resolution PQ-3318 "On further development of individual farms, dekhkan farms and landowners' organizational measures" dated October 10, 2017, Presidential Resolution PQ-4239 "On further development of agricultural cooperation in fruit-vegetable sector" dated March 14, 2019, Presidential Resolution PQ-4700 "On ensuring food security during the coronavirus pandemic, rational use of available resources, additional measures of state support of agriculture" dated May 1, 2020, and decree of President of the Republic of Uzbekistan dated October 23, 2019 "On approval of the Strategy of agricultural development of the Republic of Uzbekistan for 2020-2030" as well as in accordance with the Decree of the Cabinet of Ministers of the Republic of Uzbekistan dated January 9, 2019 No 14 "On Additional Measures for the Optimization of Land and Farmland Land Use by Farms and Other Agricultural Enterprises" and others.

Relevance of the research to the priorities of the national science and technology development. The dissertation research was done within the framework of scientific research works following the state scientific and technical program "Development of scientific foundation for further development of science and technology of the Republic of Uzbekistan, formation of civil society, modernization and liberalization of the national economy".

State of the art. A number of local and international scholars studied the problems of agrarian reforms, including land and water reforms, the efficiency of land and water use, and the effectiveness of agricultural production in the market economy settings. Among Uzbek authors Y. Gulyamov[6], I. Abdullaev and Sh. Rakhmatullayev, and among international scholars O'Hara studied agrarian reforms

[6] Яҳё Ғуломов. Хоразмнинг суғорилиш тарихи. Монография, 1959 йил; Iskandar, Abdullaev; Shavkat, Rakhmatullaev (2015): Transformation of water management in Central Asia: from State-centric, hydraulic mission to socio-political control. Environ Earth Sci. 73, pp. 849-861; Sarah, O'Hara (2000): Lessons from the past: water management in Central Asia. In Journal of Water Policy 2, pp. 365-384.

in Central Asia, especially using evolutionary perspectivein of land and water reforms in Uzbekistan. The economic efficiency of agricultural production and its theoretical foundations in Uzbekistan are mentioned in manuscripts of A.Abduganiev and A.A.Abduganiev[7], U.P.Umurzakov and O.Murtazaev.

D.Akhmedov[8], B.Sultanov, U.Sangirova, A.Ibragimov, Z.Shokhojaeva, Sh.Hasanov and S.Umarov studied the problems of agrarian reforms, in particular land and water reforms, the effective use of land and water resources. Furthermore, other foreign authors such as J.Wang, Zhigang Hu, Jikung Huang, Scott Rozelle[9], Zhang and A.Zinzani focused on land and water reforms.

Under the conditions of market relations, the reforms in the agrarian sector require a deeper study of the influence of reforms on agricultural sector performance and broader methodological issues of their assessment. In contrast to the work of the previous scientists, we focus on the evaluation of how agrarian reform effect agricultural productivity. Furthermore, to evaluate agrarian reforms we used a fixed effect model which so has not applied by local scholars.

Connection of the dissertation with the scientific-research works in the higher education institution where the dissertation was prepared. The scientific work was carried out within the framework of the research plans of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME) and the Samarkand branch of Tashkent State University of Economics, and consistent with their priorities towards sustainable development of agriculture in Uzbekistan.

Purpose of the research. The dissertation aims at the investigation and evaluation of impact of land and water reform on agricultural sector performance. By doing so, the dissertation attempts to develop proposals and recommendations

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[7] А.Абдуғаниев ва А.А.Абдуғаниев. Қишлоқ хўжалик иқтисодиёти. Дарслик. – Т., 2004 й.; Умурзаков У.П., Чориев К.А. Организационно-экономических и правовых основы реструктуризации селскохозяйственных предприятий на переходном этапе. – Т., Меҳнат, 1997. – с 79.; Муртазаев О., Ф.Б.Аҳроров. Қишлоқ хўжалик иқтисодиёти. – Т., Илм-Зиё, 2017 й.

[8] Д.Қ.Ахмедов. Пахтачилик хўжаликларида ер-сув ресурсларидан фойдаланиш самарадорлигини ошириш (Бухоро вилояти мисолида): дисс... и.ф.н. – Т., 1993; Б.Султанов. Қишлоқ хўжалигида мелиоратив тадбирлар самарадорлигини оширишнинг илмий-услубий асосларини такомиллаштириш: дисс...авт. и.ф.д. (DSc) – Т., 2020 й; У.Р.Сангирова. Сув истеъмолчилари уюшмалари ва фермер хўжаликлари ўртасидаги иқтисодий муносабатларни такомиллаштириш: дисс... и.ф.н.. – Т., 2012; М.А.Ибрагимов. Қорақалпоғистон Республикасида қишлоқ хўжалигини барқарор ривожланишини таъминлашда сув-ер ресурсларидан фойдаланишни бошқаришни моделлаштириш: дисс... и.ф.н. – Т., 2005; З.С.Шохўжаева. Қишлоқ хўжалигида сув ресурсларидан фойдаланишнинг иқтисодий самарадорлигини ошириш йўллари (Қашқадарё вилояти мисолида): дисс... и.ф.н. – Қарши, 2010; Ш.Т.Ҳасанов. Чекланган ресурслардан фойдаланиш самарадорлигининг методологик масалалари. дисс...авт. и.ф.д. (DSc) – Самарқанд, 2017.; С. Умаров. Сув хўжалиги тизимида инновацион фаолиятни ривожлантиришнинг илмий-амалий асосларини такомиллаштириш: дисс...авт. и.ф.д. (DSc) – Т., 2017 й..

[9] Jinxia, Wang; Zhigang, Xu; Jikun, Huang; Scott, Rozelle (2006): Incentives to managers or participation of farmers in China's irrigation systems: which matters most for water savings, farmer income, and poverty? In *Journal of Agricultural Economics 34, 315–330*; Zhang et al (2013): Water user's associations and irrigation water productivity in northern China; Zinzani, Andrea (2015): Hydraulic bureaucracies and Irrigation Management Transfer in Uzbekistan: the case of Samarkand Province, In *Journal of Water Resources Development, DOI: 10.1080/07900627.2015.1058765*

towards increasing the agricultural production value. Finally, the research aims at assessing the benefits from cooperation among individual farmers in water use and crop production.

Research objectives:

scientific-practical analysis of land and water reforms in Uzbekistan starting from 1991 independence;

improving the econometric model that reflects the impact of land and water reforms (such as establishment of WUAs, optimization of cultivation area of cotton and wheat, optimization individual farm sieze) on agricultural productivity;

comparative analysis of land and water reforms in Samarkand and Fergana provinces;

cross-country analysis of farm cooperation in irrigated water use and crop production in the context of agrarian reforms (by comparing Samarkand province (Uzbekistan) and Turkistan province (former South Kazakhstan province in Kazakhstan[10]));

analysis of the factors affecting farmers' cooperation decisions in water use and crop production;

development of scientific and practical recommendations toward increasing the value of gross agricultural product;

predicting agricultural sector performance by 2030.

The study objects of the research are agricultural producers such as individual farms, dekhan and agricultural enterprises in the Samarkand province, and the Zarafshon Basin irrigation system. Furthermore, we conducted comparative analysis between Samarkand and Fergana provinces, as well as between Samarkand province of Uzbekistan and Turkistan province of Kazakhstan Republic.

Subject of research. Evaluation of impact of land and water reforms on agricultural sector performance, and factors affecting cooperation among water users.

Research Methods. During our research work, the "fixed-effect" model of "Cobb-Douglas" production function approach and based on panel data was used to evaluate the impact of agrarian reform. Furthermore, we used "PROBIT" model to evaluate factors affecting the cooperation in water use and crop production.

The scientific novelty of the research is as follows:

Empirical evidence from the estimations using the fixed effect model that the expansion of grain area leads to the reduction of gross agricultural output;

Development of evaluation criteria for the assessment of the impact of land and water reforms on monetary value of gross crop output;

Based on the "PROBIT" model, estimation of the determinants of cooperation in irrigation and crop production;

[10] South Kazakhstan province has been renamed into "Turkistan" province according to the decree of president of Kazakhstan in June, 2018 https://primeminister.kz/en/news/all/16714.

Based on the analysis of efficiency of land and water reforms, prediction of increasing the agricultural crop output in Samarkand region until 2030.

The practical results of the research are as follows:

Development of a method for assessing the impact of land and water reforms on gross crop output value using a panel data model with fixed effect;

Proposition of policy measures to promote cooperation in water use and crop production;

Practical recommendations to farmers in Samarkand province on optimal land allocation based on the result of the fixed effect model and Cobb-Douglas production function.

Based on the result of "PROBIT" model, practical recommendations for promoting cooperation in water use and crop production in Paiarik, Pastdargom and Jambai districts of Samarkand province.

Reliability of research results. Scientifically-practical conclusions of the dissertation are derived based on the scientific results of agricultural economists and international scholars specializing in agrarian reforms. Furthermore, the dissertation uses long-term district-level official statistical data of the agricultural sector of Samarkand province. The dissertation also used the micro-level data from farm surveys in Samarkand province (Uzbekistan) and Turkistan province (Kazakhstan) collected in the framework of AGRICHANGE project.

Scientific and practical significance of the research results. The results of the research will allow to estimate the impact of agricultural reforms on the effectiveness of agricultural production, and develop theoretical-methodological foundation for increasing productivity in agriculture. The results of the research will also allow the prediction and planning of agricultural production through the application of an econometric model.

Moreover, the results of the research can be widely used in the development of cooperation among farmers, as well as in the educational process of higher education institutions in developing the courses on "agriculture economics" and "institutional economics".

Implementation of research results. The results of agrarian reform evaluation and cooperation determinants allow to develop the following scientific and practical recommendations:

To improve the gross crop out, the results of fixed effect model were summarized into a recommendation to optimize the cultivation area of grains. This recommendation was implemented by the Ministry of Agriculture of the Republic of Uzbekistan (Ministry of Agriculture of the Republic of Uzbekistan, May 30, 2019, reference number 02 / 032-447). As a result, the gross crop output in 2018 in Pastdargam, Paiarik, Urgut, Bulungur and Jambai districts increased by 3.7% compared to 2017 values;

A recommendation was developed to account for economic cost principle when designing irrigation water distribution as well as proving timely information on

water supply. This recommendation was implemented by the Ministry of Agriculture of the Republic of Uzbekistan (Ministry of Agriculture of the Republic of Uzbekistan, May 30, 2019, reference number 02 / 032-447). The recommendation has been put into practice in the districts of the province, and proved to lead to a positive outcome;

The recommendation that "the farmers with higher education are more interested to cooperate in water use" was implemented by the Ministry of Agriculture of the Republic of Uzbekistan (Ministry of Agriculture of the Republic of Uzbekistan, May 30, 2019, reference number 02 / 032-447). As a result in Pastdargam, Paiarik and Jomboi districts, the cooperation among farmers in crop production increased by 3.4%, and in water use by 2.5%;

In Samarkand province, farmers using direct water from a canal have higher likelihood to cooperate in water use. This recommendation was implemented by the Ministry of Agriculture of the Republic of Uzbekistan (Ministry of Agriculture of the Republic of Uzbekistan, May 30, 2019, reference number 02 / 032-447). As a result it was proved that increasing number of farms using direct water by 1% would increase the probability of cooperation by 7.1%.

Approbation of the research results. The research results were discussed at 12 international and 5 national scientific-practical conferences.

Publication of research results. In total 5 scientific articles were published based on the dissertation: 4 in local journals, and 1 in international journals recommended by the Higher Attestation Commission of the Republic of Uzbekistan.

Size and structure of the dissertation. Thesis consists of 142 pages of text, 3 chapters, a summary and a list of references. The dissertation comprises 15 tables, 26 figures, and 5 appendices.

MAIN CONTENT OF THE DISSERTATION

The **introduction** of the dissertation offers a problem background, state of the art via literature review, purpose of the research, scientific novelty, practical significance, reliability, implementation, and approbation of research results, as well as information about size and structure of the dissertation.

The first chapter of the dissertation is entitled **"An overview of development patterns of land and water reforms"** and focuses on the historical stages of land and water reforms in Uzbekistan and principles of WUA establishment in Samarkand province.

Any reforms are based on legal and policy documents, and considered as a measure which directly and indirectly affects agricultural productivity.

By the beginning of 1940, private ownership of land, water and production facilities was abolished[11]. Cotton cultivation played main role in Uzbekistan at that

[11] Peter C. Bloch (2002). Agrarian reform in Uzbekistan and other Central Asian countries. Working paper N 49.

time. Between 1929 and 1932 collectivization and "cotton self-sufficiency" were the main goals of the agriculture. "By the end of 1932, 77.5% of rural households were incorporated into 9,734 kolkhoz farms (collective farms) and 94 sovkhoz farms (state farms)[12]". A collective and state farm had on average 1500-2000 hectares of irrigated land[13].

After the independence Uzbekistan actively reformed its agriculture sector. In the onset of the independence an approach was to slowly transform collective and state farms to agricultural cooperatives (shirkats) and individual farms. Since 2004 shirkats have been completely converted into individual farms. Land optimization reform was introduced in 2009 and an average farm size ranged from 40 hectares to 100 hectares across regions. The land optimization reform was continued in 2013 making an average farm size of 30 hectares.

The forms of ownership, distribution of agricultural land and its size had been different in the pre-and post-independence in Uzbekistan. The main purpose of these reforms was to increase the agricultural productivity. In this context, the dissertation analyses the impact of post-independence reforms on the value of gross crop output.

Water users associations were established since 2000. But currently water management still has problems. Despite the establishment of WUA, water users (farmers) do not participate in water allocation decisions. Cooperation among water users is still insignificant. Payment should reflect the quality of WUA services.

The second chapter of the dissertation **"The current condition of land and water reforms and cooperation in agriculture"** focuses on the description of the study area, the principles of the establishment of the WUA in Samarkand province. In this chapter we describe agrarian reforms, and provide a comparative analysis of agriculture in Samarkand and Fergana provinces. Furthermore, the chapter provides an analysis of the current situation of cooperation in agriculture. The comparative part of the research is based on the official statistical data of the Ferghana and Samarkand province. Analysing the WUA establishment principles shows that most principles were considered in establishing WUA in Samarkand province. However, most water users in Samarkand province are not aware about WUA and consider it as part of the district water management department (former "Rayvodkhoz"). There is a significant difference in establishing WUA between Samarkand and Fergana provinces. In Samarkand, "one district – one WUA" principle was used, while Fergana province has many smaller WUAs in each district.

Furthermore, in our study we estimate cooperation in irrigation and crop production in two regions: Samarkand (Uzbekistan) and Turkistan (Kazakhstan). Main features of those two regions are given in Table 1. This table shows that two regions have significant differences in agricultural reforms in organizational, socio-economic and legal aspects. The main features of these differences have been revealed in the dissertation.

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[12] Deniz Kandiyoti (2002). Agrarian Reform, Gender and Land Rights in Uzbekistan. *United Nations Research Institute for Social Development*

[13] Ahmad Hamidov et.al. (2015) Institutional design in transformation: A comparative study of local irrigation governance in Uzbekistan. Environmental science & policy 53. pp 175-191

One of the purposes of the research is to systematically evaluate the influence of agrarian reforms on agricultural crop output. By doing so this study is focused on the question of how various reforms affected agricultural sector performance. To answer this research question, we use the case of Samarkand province which went through almost the same style of agricultural reforms as in other regions of Uzbekistan. The study is based on official statistics covering the entire post-independence period (1991-2019) in district level of Samarkand province.

Table 1.

Description of main agrarian reforms in Samarkand and Turkistan provinces[14]

	Samarkand (Uzbekistan)	**Turkistan (Kazakhstan)**
Land tenure	Long-term leases, state-mandated land allocations to strategic crops[15]	Private land ownership possible, long-term leases of state land
Farm restructuring	Land distribution after 1998, reconsolidation after 2008, average cotton farm has about 60 ha of land[16]	Dissolution of state farms in early 1990s, av. cotton farm has 6 ha of land
Land distribution process	Land distribution to individual via tender taking into account applicants' farming skills, education, assets[17]	Farm property was distributed to directors of former state farms for 5-20 years, about 80% was given to farm members[18]
Crop production	Cotton & wheat as strategic crops, state-mandated delivery quotas, price controls[19]	Crop production without government control
Water management	Role of water users in WUA decision making is low	Water users association, established by users, financially independent, weak role of water users in decision making[20]

[14] Author based on literature review

[15] Amirova, I., Petrick, M., & Djanibekov, N. (2019). Long-and short-term determinants of water user cooperation: Experimental evidence from Central Asia. World Development, 113, 10-25.

[16] Amirova, I., Petrick, M., & Djanibekov, N. (2019). Long-and short-term determinants of water user cooperation: Experimental evidence from Central Asia. World Development, 113, 10-25.

[17] Djanibekov N., Kristof, van Assche., Ihtiyor, Bobojonov & John P.A. Lamers (2012): Farm Restructuring and Land Consolidation in Uzbekistan: New Farms with Old Barriers, Europe-Asia Studies, 64:6, 1101-1126.

[18] Petrick, M., Wandel, J., & Karsten, K. (2011). Farm restructuring and agricultural recovery in Kazakhstan's grain region: An update (No. 137). Discussion Paper, Leibniz Institute of Agricultural Development in Central and Eastern Europe

[19] Petrick, M., & Djanibekov N (2015). Institutional change in land and labour relations of Central Asia's irrigated agriculture (AGRICHANGE). Project description

[20] Zinzani, A. (2015). The Reconfiguration of Participatory Irrigation Management in Water Users Associations. Evidence from Uzbekistan & Kazakhstan. *Cahiers d'Asie centrale*, (25), 133-153.

Samarkand Province has large irrigated land areas and produces cotton, wheat, vegetables, potatoes and other crops (barley, maize, melons, fruits and other crops). As a result of agrarian reforms carried out during 1991-2019, the area under cotton was reduced and wheat, vegetables, potatoes and other types of agricultural products (melons, corn, fruits, etc.) were harvested, crop areas were expanded. Figure 1 presents the share of strategic crops (cotton and wheat) area in total sown area in Samarkand province.

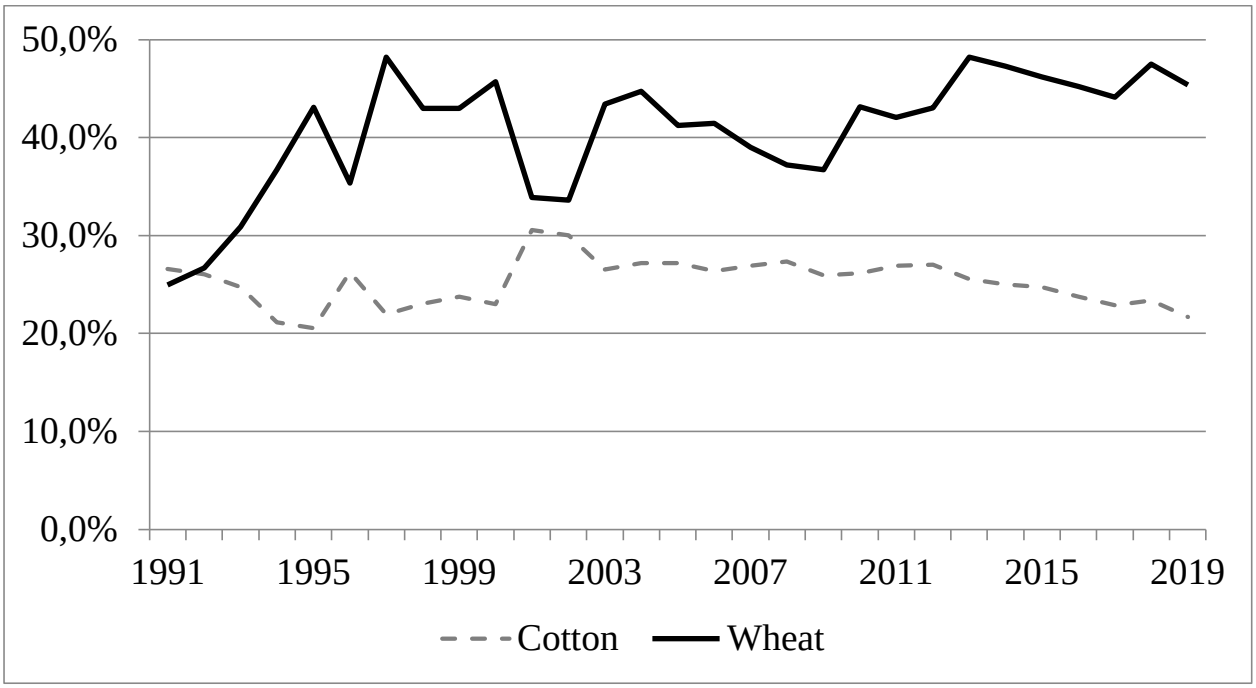

Fig.1. The share of cotton and wheat area in Samarkand province[21]

The results and conclusions of the above analysis confirm that the use of statistical and panel data in the economic evaluation of the impact of land and water reforms is important. Such approach allows to determine real production capacity, provide reliable results and recommendations, which have methodological and practical significance.

The third chapter of the dissertation entitled **"Evaluation of impact of land and water reforms on crop output and improvement of farm cooperation"** focuses on practical and scientific results, the impact of agrarian reforms on agricultural sector performance, promotion of cooperation among farmers. Moreover, the chapter describes the determinants of cooperation in water use and crop production.

The research highlights the importance of cooperation in crop production and water use in the context of the ongoing agricultural reforms. Based on empirical evidence the chapter provides a proof that cooperation among farmers is important

[21] Source: Author based on state statistic committee of Samarkand province

in solving the following problems such as unequal access to irrigation water by head- and tail-end users, weak role of WUA and can influence the the effectiveness of reforms.

In our study we are going to measure following factors that can impact agricultural productivity in the case of Samarkand province (Table 2). We use Cobb-Douglas specification with the logarithms for the dependent variable gross agricultural output. The independent variables which influence the monetary crop output are water use, sown area, agricultural employment, number of individual farms, and number of tractors. Furthermore, the model uses other independent variables such as share of individual farm, cotton and wheat area, and a dummy for the presence of WUAs.

Hence, we use Cobb-Douglas production function approach and regression model can be written as follows:

$$lnY_{it} = \alpha_i + \beta_1 \, lnx_{1,it} + \cdots + \beta_k x_{k,it} + u_{it} \qquad (3)$$

Here, Y_{it} – monetary crop output which is dependent variable given with logarithms way. x_k – (k=1…5) variables with logarithms and k=6…10 variables in a linear way.

Table 2

Potential determinants of agricultural crop output[22]

	Variable	Unit	Variable definition
1	Total water use for irrigation in June-August	mln m3	Sum of water use in June, July, August
2	Total sown area	Ha	Sown area of all types of farms
3	Employment in agriculture	Person	Labor resources employed in agriculture
4	Total number of individual farms	Farms	The number of individual farms in Samarkand province
5	Number of tractors	Piece	The number of tractors in Samarkand province
6	Share of individual farm land in total sown area	index (0-1)	Total sown area of individual farms (.000 ha) / Total sown area of all types of farms (.000 ha)
7	Share of cotton land area	index (0-1)	Total area of cotton (.000 ha) / Total sown area (.000 ha)
8	Share of wheat land area	index (0-1)	Total area of wheat (.000 ha) / Total sown area (.000 ha)
9	Data of water reform	Dummy	If WUA is present, then 1

[22] Source: Author

lnx_1 = ln(total water use for irrigation in June-August)
lnx_2 = ln(total sown area)
lnx_3 = ln(employment in agriculture)
lnx_4 = ln(number of farms)
lnx_5 = ln(number of tractors)
x_6 = Share of individual farm land area
x_7 = Share of cotton area
x_8 = Share of wheat area
x_9 = Presence of water users associations (dummy variable)
x_{10} = Time
it = i is the districts (in our case 14 districts, 14 groups), and t is time
$\beta_1 \ldots \beta_k$ – is the coefficient of each variable

We estimate three models with slightly different variables. Table 3 illustrates the model results. The results of all models indicate that water use in irrigation and total sown area display a positive effect and statistically significant impact on agricultural crop output. So, the evidence is consistent with the hypotheses that water use and total sown area have a positive impact on crop production. Our regression results show that the number of individual farms have positive effect on agricultural crop output in the model 2 and model 3. Hence, we accept the hypothesis that more farms may mean progress in restructuring state-controlled farms and thus better incentives for farmers and higher output.

Furthermore, our results show that the coefficient of the share of individual farm land area is not statistically significant in model 2 and model 3. Here, our hypothesis is not supported.

To check the impact of state procurement crops on agricultural output, we look at the relationship between the extent of cotton and wheat production on monetary crop output. According to the existing literature we expected that the dominance of these two strategic crops in land use would have a significant negative impact on the performance of agricultural sector. However, the model results show that the share of cotton land area is not statistically significant. In other words, the district's specialization did not negatively affect the crop production in this district. This can be explained that the districts specializing in cotton production receive certain state priorities in access to inputs. In contrast to cotton, there is a significant negative relationship between the share of land under wheat cultivation and agricultural growth. Thus, we can say that higher wheat area had a negative impact on crop sector in the Samarkand region.

Table 3

Estimation results of crop output value[23]

Variables	**(I)**	**(II)**	**(III)**
Ln(total water use for irrigation in June-August)	0.064* (0.036)	0.058 (0.036)	0.030 (0.035)
Ln(total sown area)	0.365*** (0.061)	0.364*** (0.060)	0.478*** (0.061)
Ln(employment in agriculture)	-0.377*** (0.099)	-0.249*** (0.101)	-0.242*** (0.099)
Ln(number of tractors)	-0.346*** (0.052)	-0.307*** (0.072)	-0.246*** (0.069)
Ln(number of farms)	X	0.043** (0.013)	0.040*** (0.012)
Share of individual farm land area	X	0.166 (0.102)	0.121 (0.098)
Presence of water users associations (dummy variable)	X	0.045 (0.050)	0.049 (0.048)
Share of cotton land area	X	X	0.322 (0.220)
Share of wheat land area	X	X	-0.558*** (0.101)
Year	-0.069*** (0.009)	-0.096*** (0.013)	-0.077*** (0.013)
Year2 (year square)	0.003*** (0.000)	0.004*** (0.000)	0.003*** (0.000)
constant	13.696*** (0.543)	12.991*** (0.625)	12.338*** (0.608)
adj. R2	0.76	0.77	0.79
Number of observations	406	406	406

Note: *p<0.1; **p<0.05; ***p<0.01, *t statistics in parentheses*

Linear prediction analysis shows that decrease in wheat area can increase agricultural crop output by 0.56%. An average share of wheat area in total sown area in Samarkand province was 40%.

To study the impact of water reforms on agricultural performance in the Samarkand region, we used a dummy variable which indicates the years of WUA presence. The model shows no statistically significant effect of the presence of water users associations on the crop output. This result can be explained by the state intervention in water use management in agriculture. Irrigation water is primarily allocated to cotton fields. This, in turn, results in non-payments and insufficient maintenance of a slowly eroding physical infrastructure.

[23] Source: Author's calculation based on official statistic data

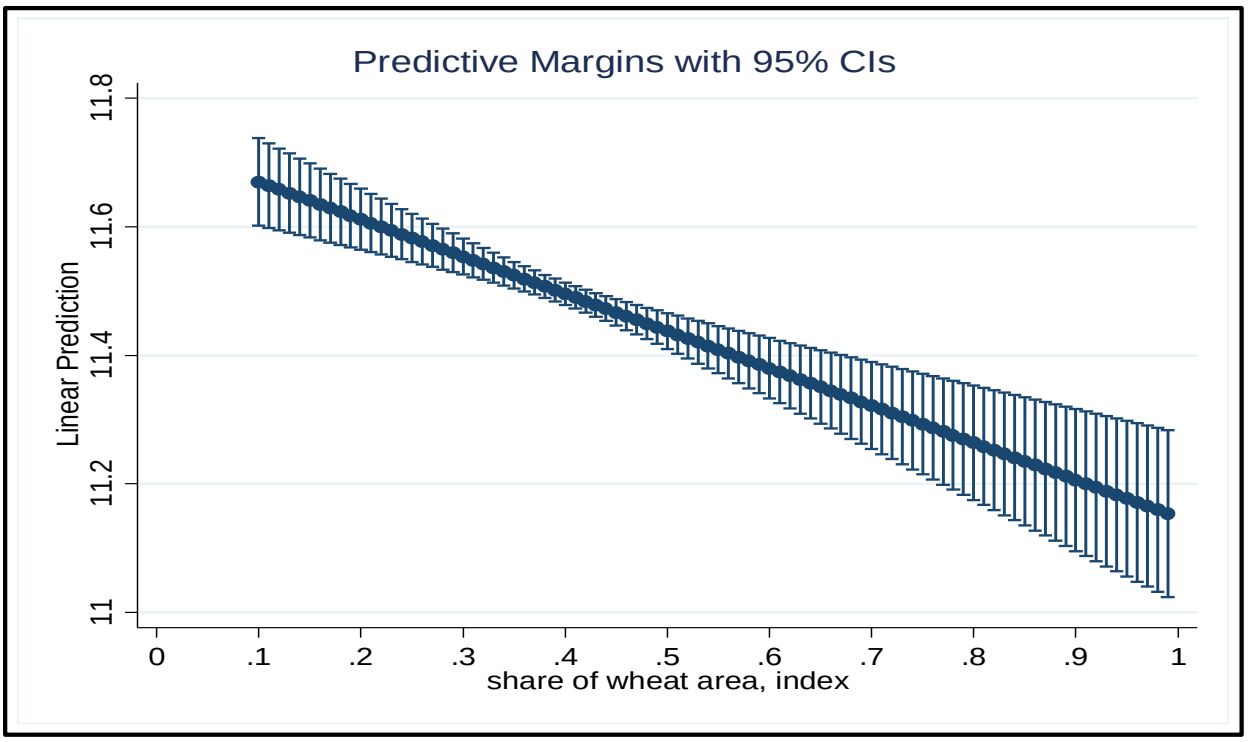

Figure 2. Linear prediction of share of wheat land area[24]

Agricultural outcome in Samarkand follows the U-shaped path as in any other transitional country. To account for this shape, the model uses time variable in a quadratic term. Finally, to account for the monotonic (linear) technological change in agriculture, we included a linear time variable. The model results show that time variable is statistically significant in agricultural performance in all three models. In other words, all models describe that in the beginning annual crop output has been decreasing and later it significantly increases over years. This is commonly assumed to be due to technical progress in the application of higher yielding varieties of crops, increased use of pesticides and fertilizers. This also may include the adjustment of production processes to the ongoing agricultural reforms, and the learning effect. The adjusted R2 shows that more than 70% of variance in agricultural output is explained by the factors considered in the model.

Furthermore, in this chapter we analyse farm cooperation in irrigation and crop production by using AGRICHANGE[25] farm survey data. In this chapter, we focus on the investigation of factors determining farm cooperation in water use and crop production to answer the main research question of "What factors influence farmers' decision to cooperate?".

In our study we are going to estimate cooperation and crop production in two regions: Samarkand (Uzbekistan) and Turkistan (Kazakhstan). In total 450 individual farms were surveyed from each country. In our study we test how age of farm manager, female farm, education of farm manager, farm size, crop type

[24] Source: Author's calculation based on model results

[25] Institutional change in land and labour relations of Central Asia's irrigated agriculture (AGRICHANGE). Project duration 1 July 2015 – 30 June 2018

variables are related to farmers' cooperation decision, as it has been done by other studies. Furthermore, we are going to test additional variables that potentially could impact cooperation. We use cooperation in water use and cooperation in crop production as dependent variables as binary variables.

Based on farm questionnaire, we picked up first five questions which could represent activities related to cooperation in irrigation such as (1) irrigation of fields, amelioration of the farmland; (2) control of water distribution for irrigation; (3) repair and cleaning of irrigation canals; (4) repair and cleaning inter-farm irrigation or drainage canals; and (5) joint maintenance, utilization, and repair of irrigation equipment (hashar). For each participation in collective action, farmer response is recorded as 1 and non-participation as 0. These responses are then aggregated into 1 if farmer participated in one of those, and zero a farmer responded about nonparticipation. For the second model we chose dependent variables as a binary choice of participating in production cooperation. We took: (1) cooperation in input supply (seeds, fertilizers, fuel, fodder etc), (2) land preparation for sowing, (3) harvesting, (4) construction and repair of processing or storage facility, (5) Sale of products, and (6) joint use of machinery and equipment variables from the farm questionnaire. Similar to the method used in cooperation in irrigation, we grouped cooperation as 1 if farmer participated in one of those activities, and zero if farmer did not participate.

In our case, the independent variables are divided into two groups: (1) Farm manager characteristics; and (2) Farm characteristics. We use farm size measured in total area of farmland. In this case, we run regression using the observations from sub-sample of farms with irrigated land. Furthermore, we use district dummy variable to estimate variance of propensity to cooperate across districts. The dependent variables are summarized in Table 4.

Table 4.

Descriptive statistics of dependent variable from the survey data[26]

Variable	Units	Samarkand					Turkistan				
		Obs	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variables											
Cooperation in irrigation (ircoop)	Dummy	367	0.14	0.34	0	1	290	0.66	0.48	0	1
Cooperation in production (prcoop)	Dummy	367	0.29	2.45	0	1	290	0.43	0.50	0	1

Figure 3 shows that more than 80% of farmers have education in agriculture. More than 60% of farmers own tractors. Despite Paiarik and Pastdargam are cotton

[26] Source: Authors based on the farm survey data.

producing districts, they have more high value crop producing farms comparing Jomboi district.

We estimate determinants of cooperation in crop production and irrigation by using PROBIT model. The results show that middle-aged farmers (46 years old) have more interest to cooperate in irrigation in Samarkand province. Farm managers' education matters in farmers' cooperation decision in Samarkand. But it does not have statistically significant relationship with cooperation in Turkistan. This can be explained by the manner of land distribution. In Turkistan, land was provided to all individuals registered in former collective farms. In Samarkand, land was distributed through auctions where applicants' education level, including in agriculture-related disciplines, contributed to applicant's total scores and increased their chance to obtain land. According to the result for the Samarkand province, if the number of high educated farm managers increases by 1% the likelihood to cooperate in crop production will increase by 3.4% and by 2.5% in water use.

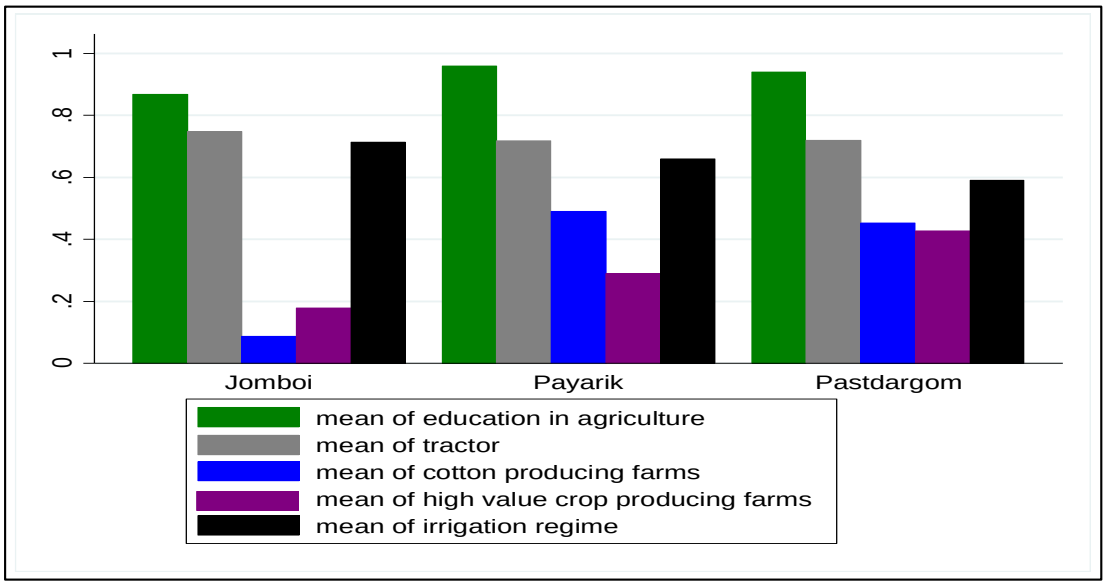

Figure 3. Description of selected farm survey variables in Samarkand province[27]

The model results show that cooperation in crop production is associated with farm size in both regions. Cotton-growing farmers in Samarkand are less likely to cooperate in water use. This can be explained by the organization of water distribution through cotton procurement system where cotton growers are prioritized in water access. At the same time, cotton growers in Samarkand are likely to cooperate with other farmers in production decisions such as storage, field preparation, transportation and marketing. The increase in number of cotton-growing farmers by 1% will increase the likelihood for farm cooperation in crop production by 10.8%, but decrease cooperation in water use by 8.8%.

[27] Source: Author's calculation based on official statistic data

In Samarkand, if a farmer irrigates its fields from canal, he/she is more likely to cooperate with other water users. In contrast in Kazakhstan the irrigation regime does not matter in cooperation in water use. Farmers' decision to cooperate is associated with the location of farm fields within irrigation system. Further away the farm fields, more likely is the farmer to cooperate in irrigation in Uzbekistan. As a result of improving cooperation, farmers will increase their output, as well as lower production costs, in particular the transaction costs. In the analysis it shows that improving land water reform and promoting farm cooperation can positively affect agricultural crop output. This can be seen in Figure 4.

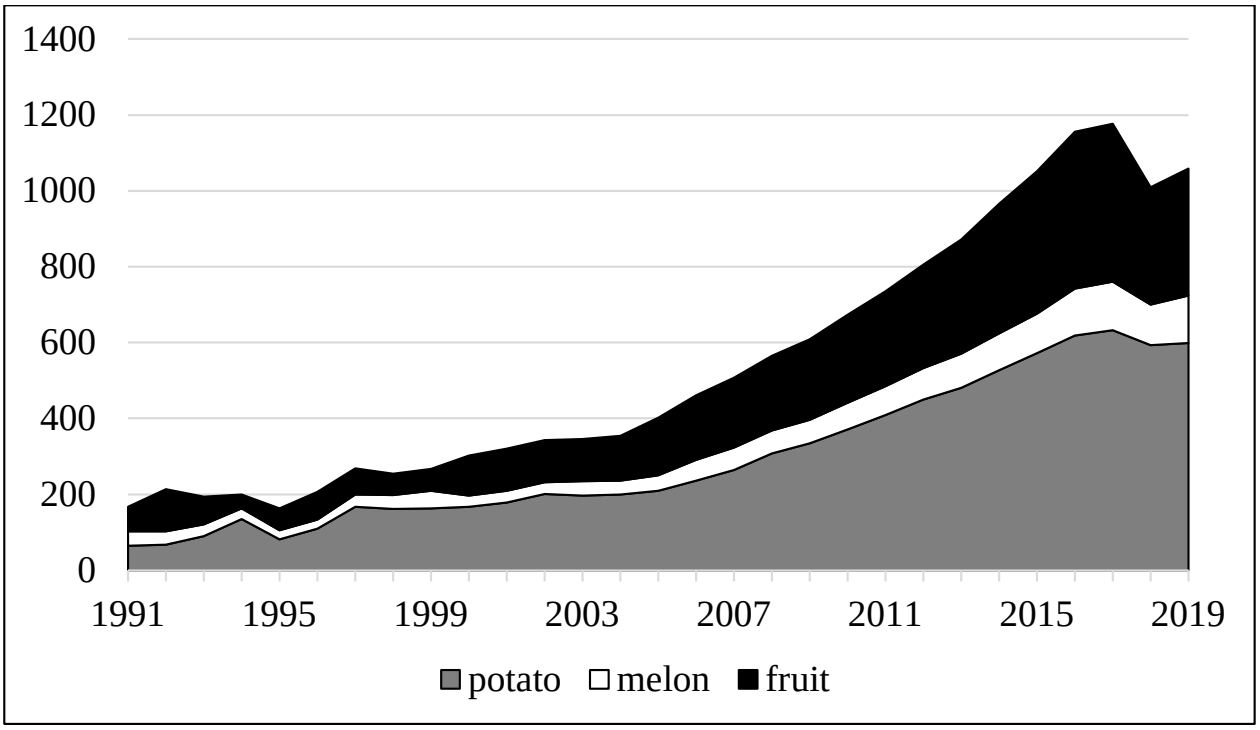

Figure 4. Dynamics of potatoes, fruits and melon production in Samarkand province (thousand tons)[28]

In general, estimating the impact of land and water reforms on agricultural crop output by applying econometric models contributes to validity and reliability of the results.

CONCLUSIONS

In this dissertation, we investigate land and water reforms and analyze which factors affect agricultural sector performance. In addition, we investigate factors determining farmers' cooperation in water use and crop production. The study results allow us to develop the following conclusions and recommendations:

[28] Source: Author based on state statistic committee.

1. First of all, it should be noted that based on the results of the research conducted in Samarkand and Fergana regions in Uzbekistan and Turkistan region in Kazakhstan, the development of agrarian reforms and farmers' cooperation have a positive impact on agricultural production. These results were derived from quantitative estimations using innovative models which are widely applied abroad.

2. The analysis shows that topical economic literature and research defines "reform" as a change, development, reorganization, improvement of an area or activity. Based on this definition, any "reform" can be understood as a set of legal acts, programs adopted and implemented to develop a particular industry, sector, management and type of activity, increase the volume, quality and efficiency of production of goods or services, as well as a set of conceptual developments, roadmaps, applied mechanisms and measures. Therefore, evaluation of impacts of any type of reform on production (service) processes is important to develop appropriate conclusions and recommendations. It should be noted that research on impact of reforms and cooperation on agricultural development in Uzbekistan is still scarce.

3. The results of the study show that the use of long-term panel data is important in assessing the relationship between land and water reform and agricultural production. In this context, the fixed effect model was used for the first time to assess the impact of reforms on gross crop output. It shows that expanding area of commercial crops is important for improving crop output value. The state policy accompanying wheat production should adopt changes similar to the optimization of cotton production area: namely, abandoning wheat cultivation on less suitable land. The model results show that 1% decrease in wheat area would increase gross crop output by 0.56%.

4. Water reform had no significant effect on agricultural output as the established WUAs lacked financial means to improve water management; there is no significantly cooperation among water users. For example, in Samarkand region there is one WUA in each district, and in Fergana region there are several WUAs per district. However, the analysis showed that in both regions, the services of WUAs had no effect on agricultural production. In our opinion, it is better to increase the role of water users in WUA decisions, while payment should be assigned according to the quality of WUA services.

5. Development of cooperation among farms is an important factor in improving the efficiency of their production. The model results show that to develop agricultural production and water use in Samarkand region, it is recommended to take into account the following factors: family labor, farm manager's knowledge, crop type, crop area, irrigation source, and location farmland along irrigation canal. According to the results, increasing the number of farms using water directly from irrigation canal will increase the likelihood of farmers' cooperation by 7.1%.

6. State crop (cotton) negatively and significantly affects irrigation cooperation. The government prioritization of water deliver to cotton fields is compromising the establishment of farmers' cooperation in water use. We recommend expanding area under commercial crops to promote cooperation in water use in Samarkand. The results can be also valid for promoting cooperation among farmers within newly established agro-clusters.