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Determinants of Sustainable Agricultural Practices in Central Asia: Empirical Evidence from Kazakhstan and Uzbekistan

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Outline

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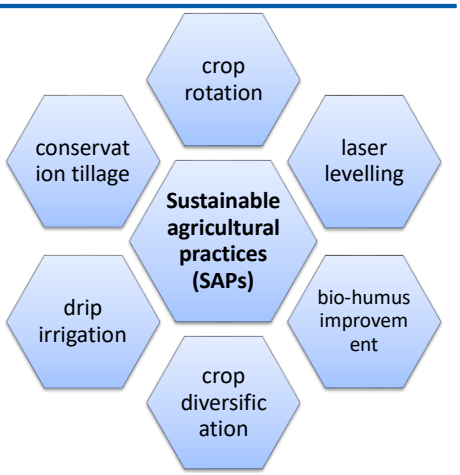
- Problem background
- Research questions
- Conceptual framework
- Study regions and data description
- Estimation method
- Results
- Conclusions and policy implications

Problem background



Sustainable agricultural practices (SAPs) produce **economic advantages for farmers**
At least at the tested field level

Source: Barham et al. (2014); Lee (2005); Liu (2013); Manda et al. (2016); Mariano et al. (2012); Zeweld et al. (2019)

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Problem background

Improving **soil productivity and farm performance** are the main issues in developing countries (Kassie et al., 2011)

Expansive and intensive land use (1924-1990), lack of land management system (after 1991) deteriorated **land degradation** in Central Asia (Nurbekov et al., 2016)

Uncontrolled irrigation led to **salinity and waterlogging** (Pender et al., 2009)

lack of crop diversification options, and old-established machinery problems leading to **low land productivity** (Kienzler et al., 2012)

Land and water degradation **decreased crop yields** and **farm income**

Conservation agriculture
(Knowler and Bradshaw, 2007; Ward et al., 2018)

Drip irrigation, Sprinkler irrigation
(Schoengold and Sunding, 2014; Shrestha and Gopalakrishnan, 1993)

Sustainable crop rotation
(Teklewold et al., 2013; Boyabatli et al., 2019)

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Main research questions

How are behavioral factors, social norms and institutional settings related with farmers' decision to adopt SAPs?

Which factors prevent or facilitate farmers' adoption of SAPs?

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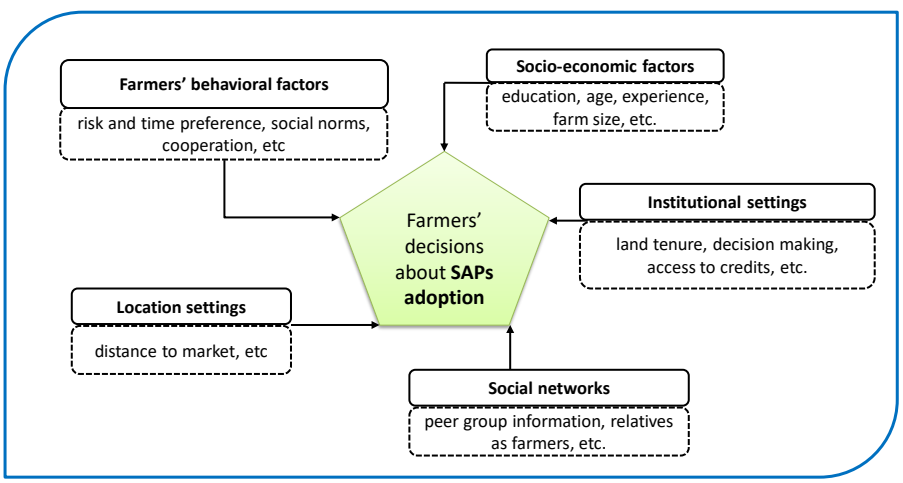
Conceptual framework



Literature: Feder, 1985; Foster and Rosenzweig, 2010; Kallas et al., 2010; Liu, 2013; Mariana et al., 2012; Manda et al., 2016; Ward et al., 2018; Dessart et al., 2019; Zeweld et al., 2019.

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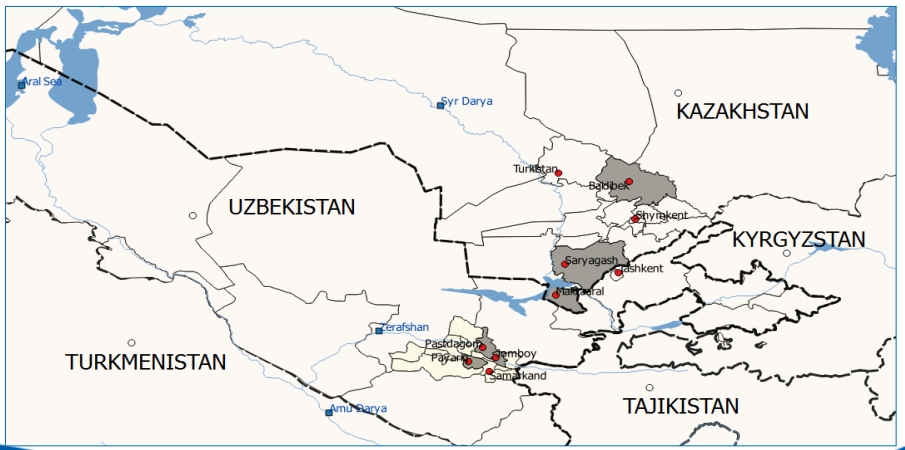
Study region

Samarkand province, Uzbekistan
Turkistan province, Kazakhstan

AGRICHANGE - Institutional change in land and labor relations of Central Asia's irrigated agriculture project, 2015



Source: Mukhamedova and Petrick (2018).

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Further information about study regions

	Kazakhstan (Turkistan)	Uzbekistan (Samarkand)
Land tenure	Long-term leases, **private land ownership** possible,	**Long-term leases**, allocations to strategic crops
Farm restructuring	Dissolution of state farms in **early 1990s**, av. cotton farm has 6 ha of land, no farm specialization	Land distribution **after 1998**, **reconsolidation** after 2008 & 2019, average cotton farm has about 90 ha of land. Since 2018, cotton cultivation transferred to private textile companies called **'clusters'**
Land distribution process	Farm property was distributed to directors of former state farms for 5-20 years, about 80% was **given to farm members**	Land distribution to individual applicants **via tender** considering certain criteria
Strategic role of agriculture	No strategic crops, direct subsidies	**Cotton & wheat are strategic crops**, Delivery quotas & procurement prices
Access to capital & inputs	**Private banks and input suppliers**, input supply via contract farming	**State agri bank**, centralized input supply and machinery services
Extension service provision	KazAgro Innovation, processors through contract farming	Public universities and research institutes

Sources: Amirova et al. (2019); Djanibekov et al. (2012); Kienzler et al. (2012);

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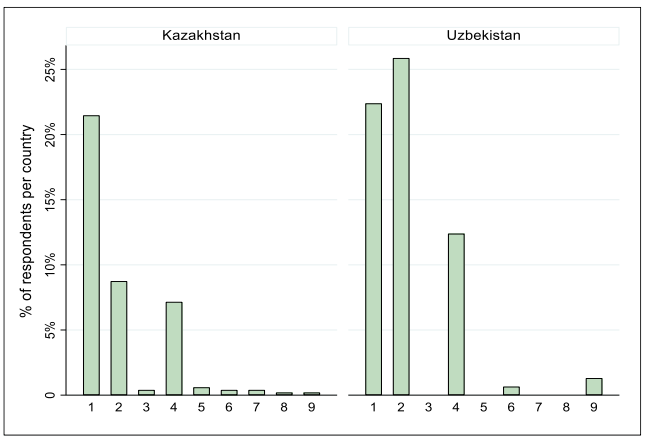
SAPs adoption rate among interviewed farmers



1 - Crop rotation

2 - Biological pest control methods

3 - Laser levelling of fields

4 - Low tillage of land

5 - Direct planting without tillage

6 - Intercropping

7 - Drip irrigation

8 - Sprinkler irrigation

9 - Bio humus

Country	Respondents
Uzbekistan (Samarkand)	**460**
Kazakhstan (Turkistan)	**503**

Source: AGRICHANGE II farm survey data (2019)

Descriptive summary of selected variables

Variable	Kazakhstan			Uzbekistan		
	Adopt **(N=160)**	Non adopt **(N=336)**	Mean diff	Adopt **(N=213)**	Non adopt **(N=247)**	Mean diff
Age of farm manager (years)	47.625 (13.309)	46.810 (13.170)	0.815	43.272 (9.854)	44.162 (10.206)	-0.890
Farm manager experience (year)	20.769 (10.622)	19.479 (9.601)	1.290	13.376 (8.490)	12.166 (7.699)	1.210
Education in agriculture (1/0)	0.388 (0.489)	0.259 (0.439)	0.129***	0.408 (0.493)	0.316 (0.466)	0.092**
Farm size (ha)	12.397 (20.565)	13.389 (25.073)	-0.991	37.384 (24.306)	40.290 (28.297)	-2.906
Risk-taker (1/0)	0.843 (0.364)	0.783 (0.413)	0.061	0.610 (0.489)	0.692 (0.462)	-0.082*
Cooperation in production (1/0)	0.181 (0.386)	0.080 (0.272)	0.101***	0.268 (0.444)	0.312 (0.464)	-0.044
Land tenure security (1/ 0)	0.925 (0.264)	0.851 (0.356)	0.074**	0.648 (0.479)	0.437 (0.497)	0.211***
Free decision on crop cultivation, crop rotation (1 to 5, categorical)	4.875 (0.350)	4.711 (0.685)	0.164***	1.554 (0.963)	1.595 (1.062)	-0.041
Number of cultivated crops (number)	1.706 (0.829)	1.759 (0.939)	-0.053	2.869 (1.056)	2.474 (0.923)	0.395***
Number of taken training courses (number)	0.400 (0.636)	0.083 (0.377)	0.317***	1.408 (1.017)	1.219 (0.946)	0.190**
Soil fertility index (0-1)	0.426 (0.469)	0.485 (0.462)	-0.058	0.605 (0.360)	0.682 (0.423)	-0.077**

Note: Standard deviation in the parenthesis. Statistical significance at the 99% (***), 95% (**) and 90% (*), t-test
Source: AGRICHANGE II farm survey data, 2019

Selected model

PROBIT model

$$Y_i = \begin{cases} 1 \; if \; a \; farmer \; adopts \; at \; least \; one \; of \; SAPs \\ 0 \; otherwise \end{cases}$$

$$Y_i = \begin{cases} 1 \; if \; a \; farmer \; adopts \; crop \; rotation \\ 0 \; otherwise \end{cases}$$

$$Y_i = \begin{cases} 1 \; if \; a \; farmer \; adopts \; conservation \; tillage \\ 0 \; otherwise \end{cases}$$

$$Y_i = \begin{cases} 1 \; if \; a \; farmer \; adopts \; biological \; pest \; control \; methods \\ 0 \; otherwise \end{cases}$$

$$Y_i^* = \delta X_i + \varepsilon_i, \quad Y_i = 1[Y_i^* > 0]$$

Literature: Abdulai, (2016); Asfaw et al. (2012); Khonje et al. (2015)

Determinants of farmer's SAPs adoption decision (marginal effect)

Kazakhstan, N=496

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Education in agriculture (1/0)	0.066	**-0.097****	0.040	**0.114*****
Cultivated crops (number)	-0.006	0.026	-0.020	-0.020
Risk-taking farmer (1/0)	**0.098***	0.043	**0.053***	0.042
Caring opinion of farmers and colleagues (categorical 1 to 5)	**0.049****	**0.036***	**0.037*****	0.016
Cooperation in production (1/0)	**0.163*****	-0.023	**0.092****	**0.060****

Uzbekistan, N=460

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Education in agriculture (1/0)	**0.084***	0.007	**0.127*****	0.045
Cultivated crops (number)	**0.068*****	**0.057*****	0.029	-0.002
Risk-taking farmer (1/0)	-0.072	**0.088***	-0.070	0.007
Caring opinion of farmers and colleagues (categorical 1 to 5)	**0.098*****	0.011	**0.058****	**-0.051*****
Cooperation in production (1/0)	-0.006	-0.033	0.016	**0.102*****

Note: * p<0.1, ** p<0.05, *** p<0.01

Determinants of farmer's SAPs adoption decision (marginal effect)

Kazakhstan, N=496

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Participation in farm trainings (number)	**0.199*** **	**0.145*** **	0.023	**0.045*** **
Land tenure security (1/0)	**0.113***	**0.135** **	0.065	0.013
Farmers trust courts to assist (categorical 1 to 5)	-0.015	-0.022	-0.002	**0.019***
Free decision on crop to cultivate, crop rotation to use (categorical 1 to 5)	**0.116*** **	**0.079** **	**0.034***	0.031
Information source about new technologies and agronomy (1/0)	**-0.148*** **	**-0.118*** **	**-0.043***	-0.039*

Uzbekistan, N=460

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Participation in farm trainings (number)	0.024	0.010	0.025	**0.029** **
Land tenure security (1/0)	**0.178*** **	**0.209*** **	0.057	0.015
Farmers trust courts to assist (categorical 1 to 5)	**-0.078*** **	-0.016	**-0.075*** **	**-0.044*** **
Free decision on crop to cultivate, crop rotation to use (categorical 1 to 5)	-0.018	-0.034	0.013	**0.031***
Information source about new technologies and agronomy (1/0)	**-0.121*** **	0.040	**-0.174*** **	**-0.134*** **

Note: * p<0.1, ** p<0.05, *** p<0.01

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Conclusions

- Farmers who care about opinion of other farmers and relatives are more likely to adopt SAPs;
- In Uzbekistan, farmers with higher education are more likely to adopt SAP, while it is an opposite among Kazakh farmers;
- Farmers, who receive information on technology and agronomy from their networks, are less likely to adopt SAP;
- Risk-taking farmers are more likely to adopt crop rotation in Uzbekistan and biological methods in Kazakhstan;
- In Uzbekistan, farmers who trust courts in assisting in disputes with local administration are less likely to adopt SAP;
- SAPs adoption in both regions is related with farmers' feeling about land tenure security;
- In Kazakhstan, farmers' opinion about freedom in what crop to cultivate and rotation to use is positively associated with SAP adoption;
- Kazakh farmers who cooperate in agricultural production are more likely to adopt SAP.

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Policy implications

- Agricultural sustainability policies will benefit from integrating information for improving local image and status of farmers who adopt SAPs;
- The governments should pay more attention in improving information about SAP among farmers;
- The regulatory environment which promotes land tenure security and farmers' autonomous decision making, particularly farmer's own adoption decision, can facilitate SAP adoption;
- While dealing with sustainable agricultural programme, the governments should also promote cooperation among farmers.

Thank you for attention!

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Study regions

Country	District	Number of respondents	Main distric characteristics
Uzbekistan (Samarkand)	Jomboy	150	Non-cotton producers, diversified
	Pastdargam	154	Mainly state crop cotton and wheat
	Payarik	156	Mainly state crop cotton and wheat
	Total	**460**	
Kazakhstan (Turkistan)	Maktaaral	171	Specializes in cotton cultivation
	Sariagash	166	Diversified in high-value crops
	Shardara	166	Specializes in cotton cultivation
	Total	**503**	

Source: AGRICHANGE II farm survey data, 2019

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The number of adopted SAPs by individual farms

Number of SAPs	Kazakhstan	Uzbekistan
0	315 (62.6 %)	227 (49.4 %)
1	152 (30.8 %)	172 (37.4 %)
2	30 (6.0 %)	41 (8.9 %)
3	3 (0.6 %)	19 (4.1 %)
4	0	1 (0.2%)

Determinants of farmer's SAPs adoption decision (marginal effect)

Kazakhstan, N=496

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Farm manager experience (year)	0.001	0.001	0.001	-0.000
Farm size (ha)	-0.001	-0.001	0.001	0.0003
Impatient farmer (1/0)	0.079	-0.014	**0.065****	0.038
Credit rationed farm (1/0)	-0.069	**-0.092****	0.016	-0.002
Farmer has a relative who manages own farm (1/0)	**0.089***	0.041	0.013	**0.119*****
Good soil fertility (index 0…1)	**-0.075***	-0.033	**-0.053***	-0.033
Distance to the district center (km)	-0.001	0.001	0.0001	**-0.002****

Uzbekistan, N=460

Variables	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Farm manager experience (year)	0.004	0.001	0.003	0.003
Farm size (ha)	-0.001	0.0002	0.001	-0.001
Impatient farmer (1/0)	-0.019	0.080	-0.012	0.035
Credit rationed farm (1/0)	0.042	0.045	-0.025	**0.086*****
Farmer has a relative who manages own farm (1/0)	**-0.079***	-0.044	**-0.093****	-0.022
Good soil fertility (index 0…1)	**-0.159*****	-0.032	-0.043	**-0.059***
Distance to the district center (km)	**0.007****	**-0.008*****	**0.010*****	**0.005****

Note: * p<0.1, ** p<0.05, *** p<0.01

Determinants of farmer's SAPs adoption decision (marginal effect)

Kazakhstan, N=496

Variables (district effect)	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Shardara	0.030	-0.030	-0.023	0.056
Sariagash	-0.009	-0.026	**-0.116*** **	**0.046***
Pseudo R2	0.162	0.123	0.266	0.275
Prob > chi2	0.000	0.0000	0.0000	0.0000

Uzbekistan, N=460

Variables (district effect)	SAPs adoption (including intercropping)	Crop rotation	Biological methods for pest control	Conservation tillage
Payarik	**-0.102***	-0.006	**-0.104***	**-0.108****
Pastdargam	**-0.181*****	-0.045	**-0.184*****	**-0.155*****
Pseudo R2	0.181	0.221	0.186	0.312
Prob > chi2	0.000	0.000	0.000	0.000

Note: * p<0.1, ** p<0.05, *** p<0.01

sustainable agriculture

- sustainable agriculture can be defined as efficiently using available resources, on the aim of improving productivity, as well as management and maintenance of resources in a way that accommodate individuals' requirements for today and for future generations . (Acharya 2006; Zeweld, Van Huylenbroeck et al. 2017)