The Impact of Climate Change on the Agricultural Output in Kyrgyzstan

LiK

The Impact of Climate Change on the Agricultural Output in Kyrgyzstan

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OSCE Academy EGD'2025

10/11/2025

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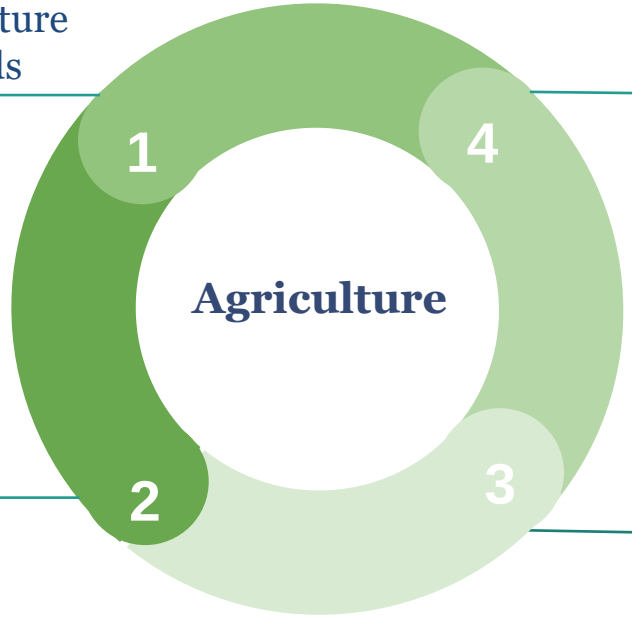
Introduction

Role in the Economy

- 15% of GDP comes from agriculture
- 60% of rural population depends on farming

Geographic & Climate

- Mountains cover about 80% of the country's territory, with an average altitude of 2,750 meters above sea level
- Climate Types (Köppen-Geiger Classification):
  - Dsa – Cold climate with hot, dry summers & snowy winters
  - BSk – Steppe climate with cold temperatures & moderate rainfall
- 80% of arable land depends on irrigation



Food Security & Nutrition

- Household Spending on Food:
  - 48% for average households
  - 70% for low-income households
- Malnutrition Challenges:
  - 50% of women & 7% of children are overweight
  - 42% of children, 40% of pregnant women, 33% of adults lack Vitamin A
  - 50% of the population consumes < 2,100 kcal/day

Climate Change Impact

- Temperature Rise:
  - +2.4°C in the last 30 years
  - Projected +2.7°C by 2050
- Kyrgyzstan is highly vulnerable due to its sensitive agricultural systems

Sources: Statista, 2024, https://www.statista.com/statistics/528614/share-of-economic-sectors
Climate-Smart Agriculture, https://climateknowledgeportal.worldbank.org/sites , FAO, World Bank, UNDP

Introduction

- **Research question:** What is the impact of climate change on agricultural output in Kyrgyzstan?

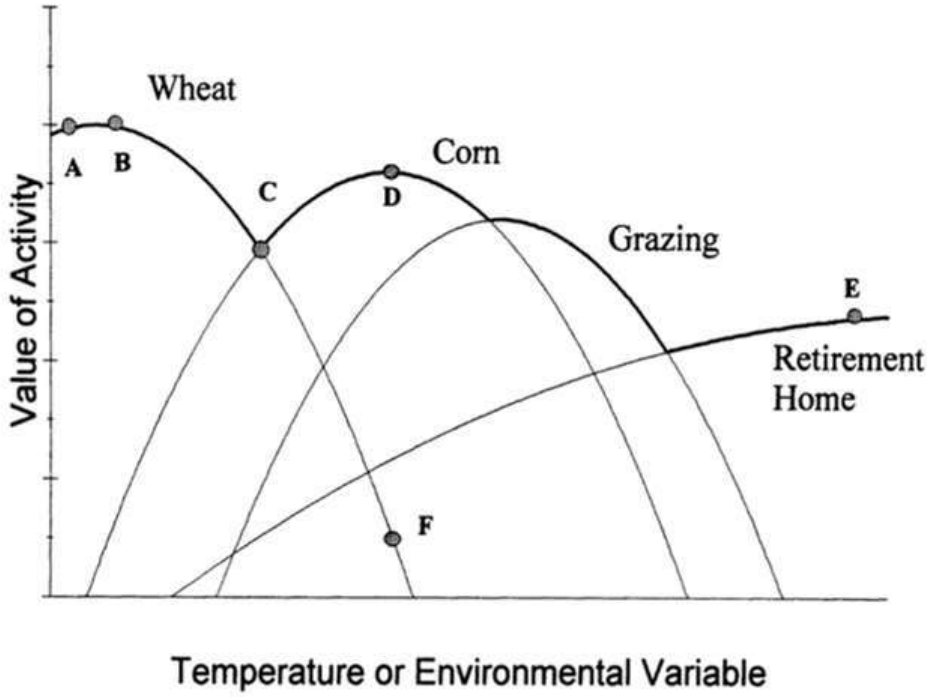
- **Research sub-questions:**
  - What are the impacts of climate shocks and weather variables on fruits, vegetables, grains, and other crops?

  - What are the impacts of climate shocks and weather variables on individual crops, such as potatoes, apples, tomatoes, corn, apricots, carrots, barley, sainfoin, lucerne, and grass for livestock?

- **Aim:** To conduct an empirical study on the effect of climate change factors on the output of different crop yields using Life in Kyrgyzstan household survey data.

Theoretical Framings

Bias in Production-Function Studies



- Conventional production economic theories do not explicitly account for the impact of climate change on agricultural output.
- The Ricardian Approach, based on David Ricardo's land value studies, was adapted by Mendelsohn et al. in 1994 to include climate change and has been applied in 46 countries. The approach is applied to cross-sectional analysis
- Criticisms: Irrigation bias and Price sensitivity.
- Deschênes and Greenstone proposed the Panel Approach for analyzing crop yields and for addressing weaknesses of the Ricardian Approach.

Sources: Mendelsohn et al. (1994) and Carter et al. (2018)

Literature Review

Positive Findings	• Rise in rainfall benefits non-food crops in India (Guntukula et al., 2020) • Rise in rainfall increases cereal yields in Türkiye (Chandio et al., 2020)
Negative Findings	• Extreme heat lowers productivity and increases land sales (Aragón et al., 2019) • Dry season temperature and decrease in rainfall reduce net revenue from farmland in the absence of adaptive measures in Vietnam (Huong et al., 2019) • Southeastern Kyrgyzstan is highly vulnerable to drought (Liang et al., 2021) • 60% of Issyk-Kul farmers face water shortages due to poor management (Jalilova et al., 2024)
Mixed Findings	• U-shaped temperature effect: Beneficial up to ascertain degree, then harmful (China) (Chandio et al., 2019) • CO_2 emissions harm yields, while rainfall and temperature have short-term benefits but long-term drawbacks (China) (Chen et al., 2016) • Recent warming poses challenges on crop yields in Kyrgyzstan (Chi et al., 2020)
Methodology	• The main sources of endogeneity are omitted variables like climate adaptation, productivity shocks, and irrigation practices. • Studies address this using household controls and instrumental variables.

Literature Review

- **Literature Gap:**
  Most studies use cross-sectional, time-series, or country-wide data, with limited research focused specifically on Kyrgyzstan.

- **Contribution:**
  This study fills the gap by using household-level panel data to analyze crop-specific impacts in Kyrgyzstan. It also integrates climate shocks and weather variables to provide country-specific recommendations for mitigating climate change effects on agriculture.

- **Hypothesis:**
  This paper hypothesizes that climate change has a negative effect on agricultural output

Methodology and Model Specification

$$log(Y)_{ti} = \beta_0 + \beta_1 climate\_shocks_{ti} + \beta_2 rain\_days_{ti} + \beta_3 max\_precip_{ti} + \beta_4 max\_temp_{ti} + \beta_5 min\_temp_{ti} + \beta_6 piped\_water_{ti} + \beta_7 irrig\_canal_{ti} + \beta_8 compost_{ti} + \beta_9 fertilizers_{ti} + \beta_{10} field\_size_{ti} + \beta_{11} gender_{ti} + \beta_{12} age_{ti} + \beta_{13} fin\_literacy_{ti} + \beta_{14} houshold\_size_{ti} + \beta_{15} year\_2019_t + \beta_{16} nw\_zone_i + \beta_{17} sw\_zone_i + \beta_{18} ne\_zone_i + \mu_i + \varepsilon_{ti}$$

Categories	Variables
Dependent variable	• revenues (fruits, vegetables, grains, and other crops) • yields (fruits, vegetables, grains, other crops and ten individual crops)
Climate change explanatory variables	• climate change caused shocks, annual rainy days, annual precipitation rate, maximum temperature, minimum temperature
Household's socioeconomic control variables	• irrigation (piped, canal, river, well), compost (presence), fertilizers (presence), gender (head's gender), age (head's age), fin_literacy (confidence in finance), household_size (total members), year (year dummy)
Regional control variables	• north-west climatic zone (Talas, Chui, Bishkek), south-west climatic zone (Osh, Batken, Jalal-Abad, Osh city), north-east climatic zone (Issyk-Kul)

Estimation Method: OLS estimation may be biased due to endogeneity from unobserved variables, so Fixed Effect and Random Effect methods are used to correct it.

Data Description

- **Life in Kyrgyzstan (LiK) Survey:** Household-level panel data from 2016 and 2019, covering demographics, agriculture, employment, and economic factors.
- **Visual Crossing Database:** Weather data including annual precipitation, rainy days, and temperature trends for 2016 and 2019.
- **National Statistical Committee of Kyrgyz Republic:** Crop price data across different regions and years, used to calculate crop revenue.

Fruits	apricot, watermelon, grapes, cherry, pears, pomegranate, blackberry, strawberry, figs, raspberries, peach, plums, currant, persimmon, apples
Vegetables	eggplant, cabbage, deciduous vegetables, onion, cucumbers, tomatoes, radish, salad greens, beetroot, pepper, garlic, carrots, tomatoes, potato, pumpkin
Grains	lucerne, corn, nuts, spring whea, rice, peas, beans, barley, winter wheat
Other	cotton, sainfoin, other, grass for feed, tobacco

Data Description: Summary Statistics

Summary Statistics of Independent Variables

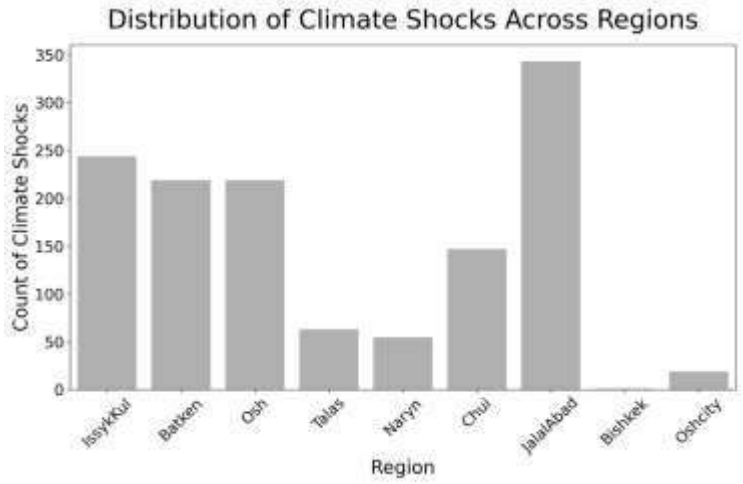
Variable	Obs	Mean	Std. Dev.	Min	Max
hhid	5,991	5579.347	2761.205	2005	21807
field	5,991	1.346186	.5726094	1	6
compost	5,991	.7033884	.4568019	0	1
fertilizers	4,981	.118	.323	0	1
piped water	4,461	.2	.4	0	1
irrig canal	4,461	.544	.498	0	1
river well	4,461	.214	.41	0	1
fin liter	5,917	.279	.449	0	1
gender	5,008	1.255	.436	1	2
age	5,008	55.3	13.074	19	91
household size	5,008	5.902	2.578	1	20
climateshock	3,386	.551	.498	0	1
year	5,991	.433	.496	2016	2019
field size	5,052	6.864	8.171	.02	95
nw czone	5,991	.099	.299	0	1
sw czone	5,991	.609	.488	0	1
ne czone	5,991	.286	.452	0	1
ct czone	5,991	.003	.054	0	1

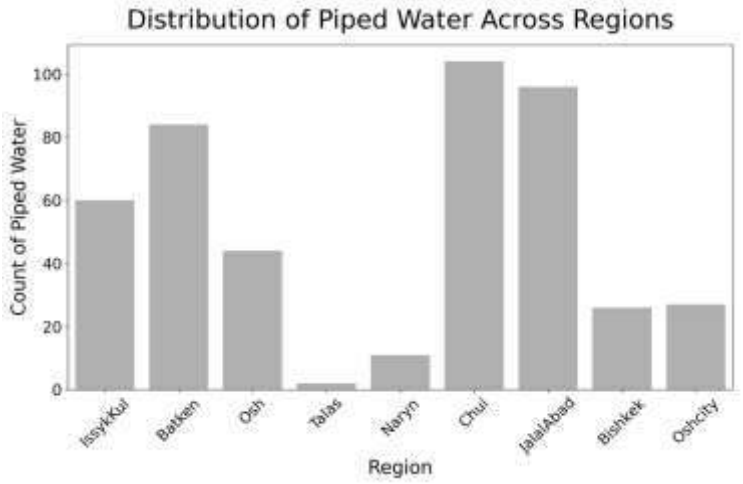
Sources: LiK

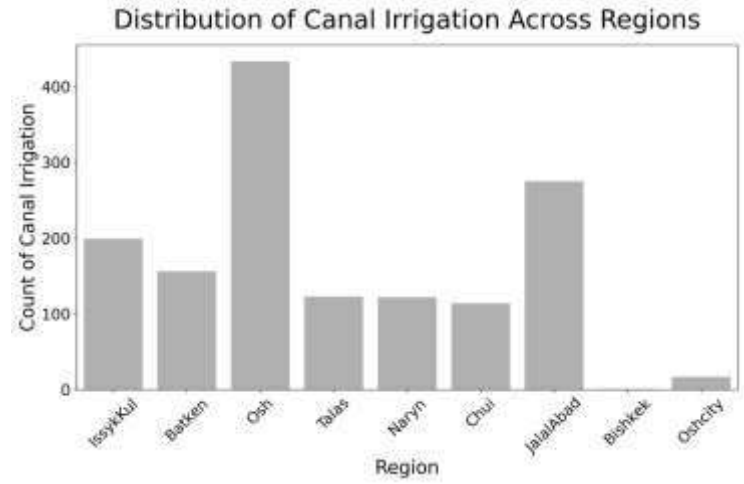
Summary Statistics of Dependent Variables

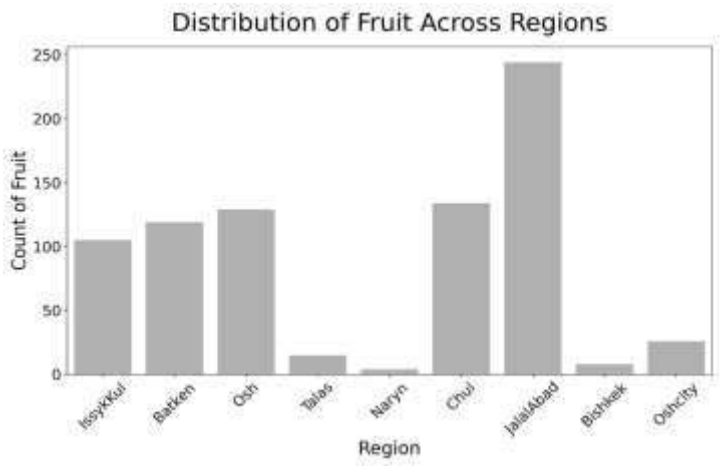
Variable	Obs	Mean	Std. Dev.	Min	Max
log fruit	1003	9.729	2.398	1.374	28.998
log vegetable	1219	9.226	2.116	.625	23.585
log grain	1086	10.267	2.834	.024	26.938
log other	754	9.869	2.164	.774	29.934
log apple	711	5.623	2.47	.693	25.328
log corn	448	6.156	2.223	.148	10.82
log potato	1025	6.034	1.748	.02	11.513
log lucerne	182	6.335	2.747	.039	23.026
log carrots	227	4.953	1.475	.131	12.206
log tomatoes	778	4.792	1.384	.693	18.421
log grass	100	6.374	2.347	2.996	25.328
log sainfoin	323	7.721	2.406	.278	12.261
log barley	133	7.545	1.581	.336	14.509

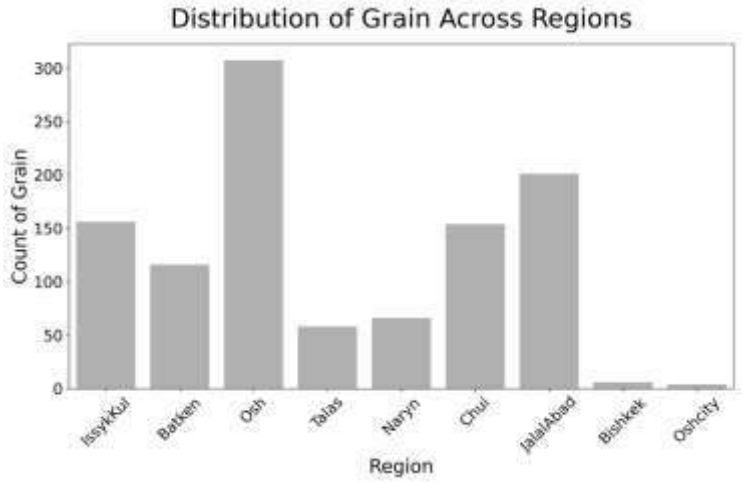
Descriptive Statistics

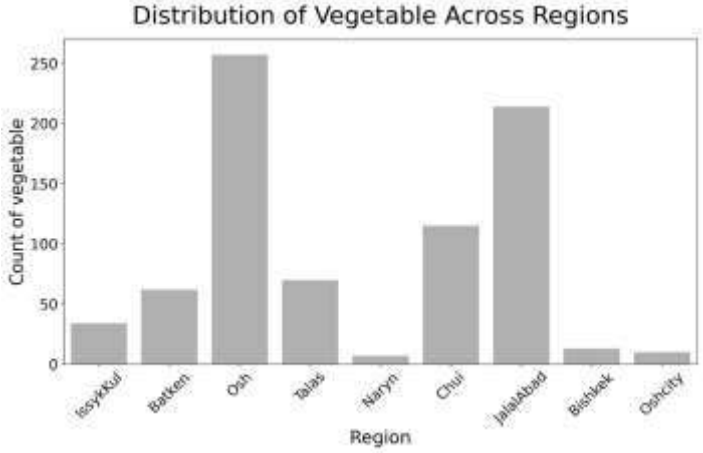












Results

Climate Shocks & Weather	• Fruits are most sensitive, while vegetables and grains are more resilient. • Rainy days: Vegetables & other crops (+), Grain yields (-). • Precipitation: Overall crop output (-), but Grain yield (+). • High temperatures: Fruit & grain yields (-), Other crops (+).
Irrigation & Land use	• Irrigation: Piped & canal decreases crop yields compared to river irrigation. • Field size: Larger fields ↑ Fruit & grain yields (+). • Compost: ↑ Grain yield (+). • Fertilizers: ↑ Grain yield (+), but ↓ Vegetable & other crop outputs (-).
Household Characteristics	• Male-headed households: ↓ Fruit & other crop yields (-). • Financial literacy: ↑ Grain yield (+). • Household size: Larger families ↑ Vegetable, grain & other crop yields (+). • Year effect: 2019 ↑ Vegetable & other crop outputs (+), ↓ Grain yield (-) vs. 2016. • Regional differences: Yields ↑ in different climatic zones (+) vs. Central Tian Shan.

Policy Recommendations

Main Stakeholders

Government

- **Ministry of Emergency Situations of the Kyrgyz Republic:** Strengthen the regional weather monitoring systems to better track climate impacts.
- **The Department of Water Resources and Land Improvement:** Improve irrigation infrastructure in well and canals.
- **Agrarian Institute together with Ministry of Agriculture:** Organize training sessions and TV programs on agricultural optimization methods. Focus on teaching local farmers to apply climate-resilient practices, including the use of organic fertilizers and compost.

Farmers

- Farmers need to adopt climate-resilient crop varieties and improve harvest practices using new knowledge from training and monitoring systems.
- Actively participate in training sessions and improve their financial literacy for making investments in agriculture.

NGOs

- **Women's Participation:** Encourage women's involvement in training programs to enhance agricultural productivity.
- **Collaboration with NGOs:** Engage NGOs in promoting financial literacy and providing assistance to local farmers.

Conclusion

- The study rejects the hypothesis of a uniformly negative impact of climate change on agriculture.
- Both positive and negative impacts were observed on crop yields, with climate shocks, weather variables, and irrigation playing key roles.
- Financial literacy and compost/fertilizer use significantly improve crop yields.
- Regional Variation: Crop sensitivity varies by region and crop type (e.g., temperature and rainfall affect different crops in varying ways).

- Limitations:
  - Focus on Crop Yields: The study only considers crop yields, excluding livestock production.
  - Short-Term Data: Data used only covers two years, limiting long-term climate change analysis.
  - Climate Measurement: Only climate shocks and weather variables were considered, rather than long-term temperature changes.

References

- Statista, 2024, https://www.statista.com/statistics/528614/share-of-economic-sectors
- Climate-Smart Agriculture,https://climateknowledgeportal.worldbank.org/sites
- “Short and long-run impacts of climate change on agriculture: an empirical evidence from China.” , https://www.emerald.com/insight/1756-8692.htm
- “Empirical analysis of climate change factors affecting cereal yield: evidence from Turkey.” https://doi.org/10.1007/s11356-020-07739-y
- “Agricultural production at the oblast level in post-Soviet Kyrgyzstan, 1990–2014: Implications of demographic and climate changes.” https://doi.org/10.1016/j.resglo.2020.100027
- Guntukula, Raju. “Assessing the impact of climate change on Indian agriculture: Evidence from major crop yields.” https://doi.org/10.1002/pa.2040
- “Economic impact of climate change on agriculture using the Ricardian approach: A case of northwest Vietnam.” https://doi.org/10.1016/j.jssas.2018.02.006
- “Climate Extreme and Agriculture Development: Fresh Insight From Top Agri-Economics.” https://doi.org/10.3389/fenvs.2021.807681

Thank You!

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