ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

Measure 5. Improving Soil Fertility through Crop Rotation, Irrigation, Precision Agriculture, and Sustainable Agricultural Technologies

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КЫРГЫЗ РЕСПУБЛИКАСЫНЫН ЭКОНОМИКА МИНИСТРЛИГИ

КЭУ ИИУ

Европа Биримдиги тарабынан биргелешип каржыланат

Schweizerische Eidgenossenschaft
Confédération suisse
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Project Context

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

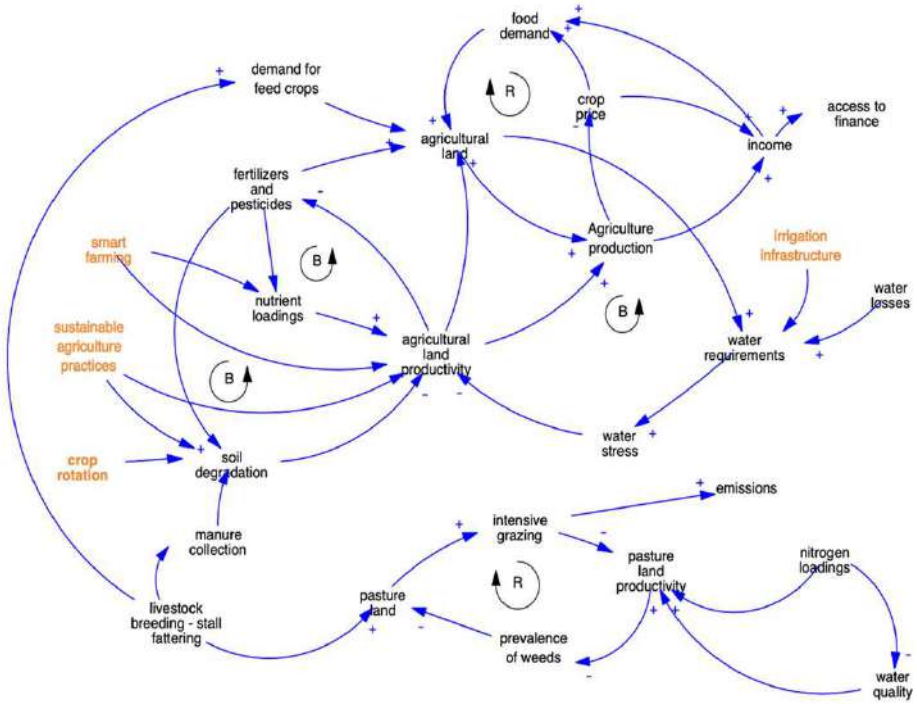
- Soil Degradation
  - Soil degradation reduces yields, water retention, and the resilience of agricultural production.
  - Salinization, waterlogging, and depletion of irrigated land are intensifying.
  - This constrains food security and rural incomes.
- Policy Question
  - Which measures are more effective for improving soil fertility: standalone solutions or an integrated approach?
  - Should support be linked to mandatory crop rotation, precision agriculture, and sustainable practices?
- Importance for the Economy
  - Agriculture accounts for about 12% of GDP and over 25% of employment, while arable land makes up only 7% of the Kyrgyz Republic.
  - The analysis is important for the interagency commission under the Ministry of Economy and Commerce and for relevant state bodies.

Assessment Objectives and Methodology

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- Assessment Objectives
  - Assess the impact of support measures and agricultural technologies on soil fertility and sector performance through 2050.
  - Compare scenarios in terms of economic, environmental, and social effects.
- Indicators
  - Land-use structure.
  - Crop output and total revenue.
  - CO_2 and N_2O emissions.
  - Employment and profitability.
- Main Partner / Client
  - Government bodies of the Kyrgyz Republic responsible for agricultural, water, investment, and environmental policy.
- Methodology
  - Scenario analysis based on a system dynamics model for 2026-2050.

Assessment Objectives and Methodology



- Baseline for 2026: 65,851 ha sustainable, 13,223 ha precision, and 10,590,100 ha conventional agriculture.
- In Scenario 4, by 2050 precision agriculture rises to 542,724 ha and sustainable agriculture to 1,429,596 ha.
- Overall, innovative methods account for 22.5% of all agricultural land by 2050.
- Conventional agriculture decreases by 1.83 million ha relative to 2026.
- The total area under improved methods reaches 1,972,320 ha, which is 1,519,951 ha above BAU.

Implementation Process

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

The results have been prepared for discussion with government bodies and interagency structures.

- Data
  - Data on land use, crop output, revenue, emissions, and employment.
  - Parameters of the sustainable agriculture, precision agriculture, crop rotation, and irrigation scenarios.
  - The results require further discussion and refinement regarding the soil carbon balance.

Scenarios Analyzed

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- BAU — continuation of current policy and limited adoption of new technologies.
- Scenario 1 and Scenario 2 provide for active adoption of sustainable and precision agriculture.
- Scenario 3 — active deployment of efficient irrigation systems.
- Scenario 4 — integrated approach: precision agriculture + sustainable practices + mandatory crop rotation.

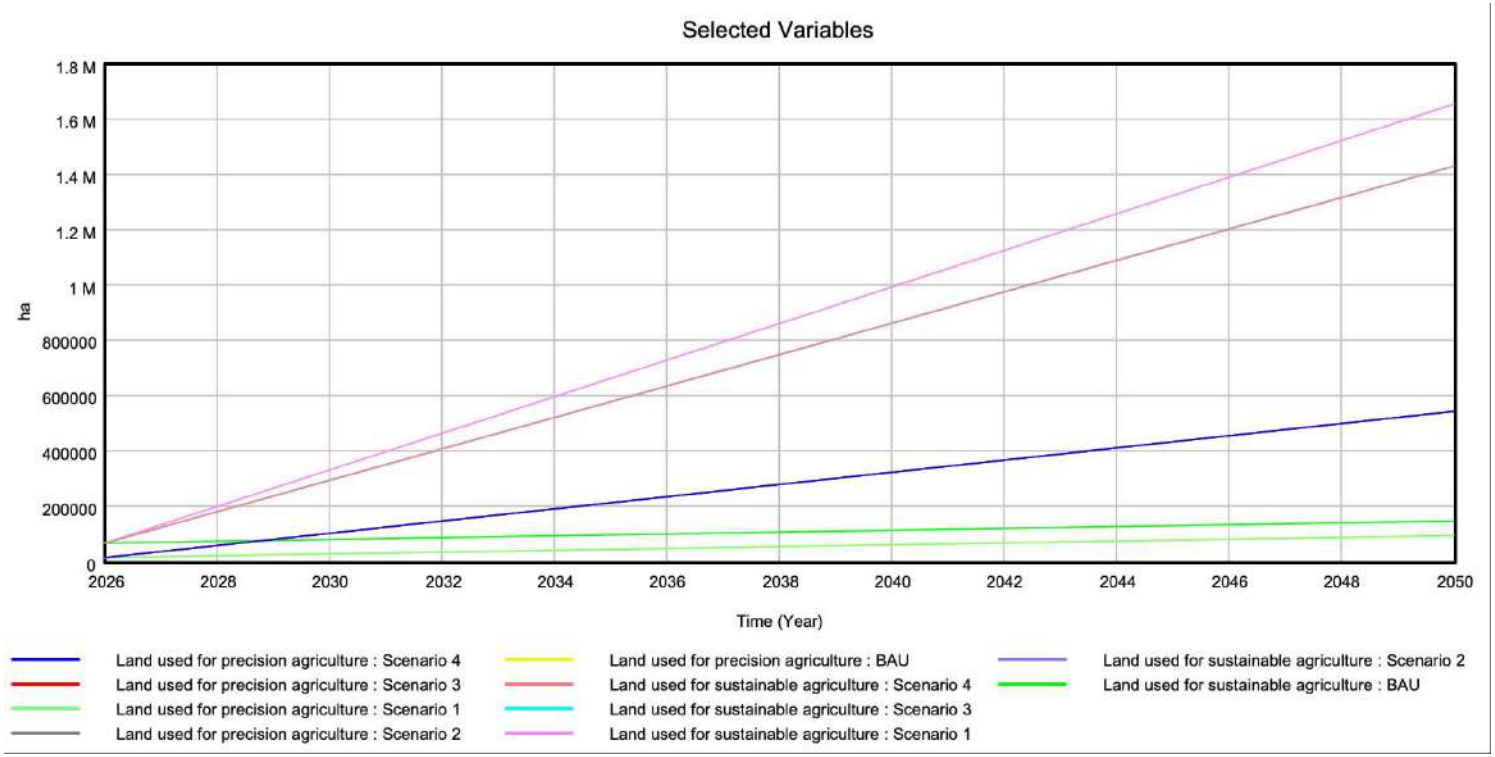
Scenarios Analyzed: Land-Use Transformation in the Target Scenario (1 of 2)

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Scenarios Analyzed: Land-Use Transformation in the Target Scenario (2 of 2)

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА



Scenarios Analyzed: Impact of the Integrated Approach on Output and Profitability

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- In Scenario 4, sustainable-agriculture output reaches 4.31 million tons in 2050, versus 0.106 million tons in BAU.
- Sustainable-agriculture productivity in Scenario 4 is 40.7 times higher than in BAU.
- Total output in 2050 amounts to 34.47 million tons, versus 29.50 million tons in BAU.
- Only in Scenario 4 does sustainable agriculture become profitable, with a profitability ratio of 2.75.
- In the other scenarios, sustainable agriculture remains loss-making at 0.66-0.83.

Scenarios Analyzed: Comparing Scenarios – Revenue, Output, Employment and Sustainability (1 of 3)

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- BAU: revenue KGS 955.36 bn, output 29.50 million tons, employment about 69.5 thousand people.
- Scenario 3: revenue KGS 1,007.98 bn, output 31.46 million tons, but sustainable agriculture remains loss-making.
- Scenario 4: revenue KGS 1,107.03 bn, output 34.47 million tons, employment 72,015 people.
- Scenario 4 vs BAU: +KGS 151.67 bn in revenue and +2,524 jobs.
- Scenario 4 is the only case in which sustainable agriculture is profitable and creates a synergistic effect.

Scenarios Analyzed: Comparing Scenarios – Revenue, Output, Employment and Sustainability (2 of 3)

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

Таблица 4. Совокупная урожайность по сценариям, 2050 г. (тыс. тонн)

Показатель	**BAU**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Традиционное	29 157,3	24 890,1	24 267,6	28 446,1	28 446,1
Точное	236,6	236,6	1 377,2	1 721,5	1 721,5
Устойчивое	105,7	1 199,4	1 036,5	1 295,6	4 306,5
ИТОГО	29 499,6	26 326,1	26 681,3	31 463,2	34 474,1

Scenarios Analyzed: Comparing Scenarios – Revenue, Output, Employment and Sustainability (3 of 3)

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

Таблица 3. Совокупная выручка по сценариям, 2026-2050 гг. (млрд сомов)

Сценарий	2026	2040	2050	Изменение 2026-2050	Отклонение от BAU в 2050
BAU	955,36	958,62	955,36	+0,9%	—
Scenario 1	955,36	963,25	977,64	+2,3%	+22,28 млрд
Scenario 2	955,36	977,43	993,15	+4,0%	+37,79 млрд
Scenario 3	955,36	982,56	1 007,98	+5,5%	+52,62 млрд
Scenario 4	955,36	1 045,67	1 107,03	+15,9%	+151,67 млрд

Scenarios Analyzed: Economic, Environmental and Institutional Effects of the Integrated Scenario

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- Scenario 4 adds an estimated 0.5-0.7 percentage points to GDP relative to BAU.
- N_2O emissions in 2050: BAU — 1,481.9 thousand tons; Scenario 4 — 2,510.7 thousand tons.
- CO_2 emissions in 2050: BAU — 28,114.3 thousand tons; Scenario 4 — 29,815.0 thousand tons.
- By the ratio of added revenue to added emissions, Scenario 4 is 4.2 times more efficient than Scenario 3.
- Per-hectare emission intensity is lower under the new methods than under conventional agriculture; absolute emissions rise because land area expands.
- Implementation requires monitoring, digital skills, access to technology, and oversight of the targeted use of support.

Scenarios Analyzed: Comparative Analysis of Scenarios

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

Таблица 7. Сравнительная характеристика сценариев

Сценарий	**Выручка 2050 (млрд)**	**Урожайность 2050 (млн т)**	**Эмиссии CO_2 2050 (тыс. т)**	**Занятость 2050 (чел)**	**Рентабельность устойчивого**
BAU	955,36	29,50	28 114	~69 500	0,66 (убыточно)
Scenario 1	977,64	26,33	~29 500	~70 000	0,66 (убыточно)
Scenario 2	993,15	26,68	~29 800	~70 500	0,83 (убыточно)
Scenario 3	1 007,98	31,46	30 662	~71 000	0,83 (убыточно)
Scenario 4	1 107,03	34,47	29 815	72 015	2,75 (прибыльно)

Analysis

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- What do the results show? Are there side effects or synergies?
  - Only the integrated scenario simultaneously increases revenue, productivity, and eco-economic efficiency.
  - Synergy: precision agriculture raises efficiency, sustainable practices restore soils, and crop rotation boosts productivity.
  - Side effects: higher absolute emissions, limited competencies, and an investment gap.
- What policy recommendations can we propose?
  - Prioritize integrated projects over standalone measures.
  - Introduce mandatory agrochemical monitoring on land receiving support.
  - Develop advisory services, training, and cooperation to improve access to machinery.
- What areas require further work and analysis?
  - Assessment of the soil carbon balance.
  - Sensitivity analysis for prices, technology costs, and climate shocks.

Conclusion

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

- Problem Statement
  - Soil degradation constrains the productivity, resilience, and growth of the agricultural sector of the Kyrgyz Republic.
- Method and Scenarios
  - A system dynamics model was used to compare scenarios through 2050, including BAU and the integrated scenario.
- Results
  - Scenario 4 delivers the largest revenue gain: +KGS 151.67 bn relative to BAU.
  - Only in this scenario does sustainable agriculture become profitable, while employment rises by 2,524 jobs.
- Policy Recommendations
  - State support should be linked to crop rotation and the adoption of precision technologies.
  - Priority should be given to integrated programs with soil monitoring, training, and phased scale-up.

ЦЕНТР ЭКОНОМИЧЕСКОГО МОДЕЛИРОВАНИЯ И АНАЛИЗА

Thank you for your attention!

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