Ecosystems, Land Use, Agriculture, Water, Salinization & Biodiversity

Case of Uzbekistan

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Lecture for Master's Program Students

Uzbekistan: Ecological-Geographic Profile

Total area	447,400 km²; Population: 37.4 mln (2025)
Arable land	Only 13.9% of total area (4.07 mln ha); 71% pasture
Climate	Arid continental; avg temp 13°C; 100–300 mm rainfall
Water resources	Amu Darya & Syr Darya basins; 90%+ used for irrigation
Rural population	~49% live in rural areas; agriculture = 23.4% of GDP (2024)
Biodiversity	4 ecoregions, 27,000+ species; Aral Sea ecological crisis zone

Source: stat.uz (2024), FAO

Agriculture in Uzbekistan: Key Metrics

24.1M

hectares agr. used
(65.95% of total area)

23.4%

share of GDP
(2024)

3.4M

employed in
agriculture

49%

population
in rural areas

~1.5M

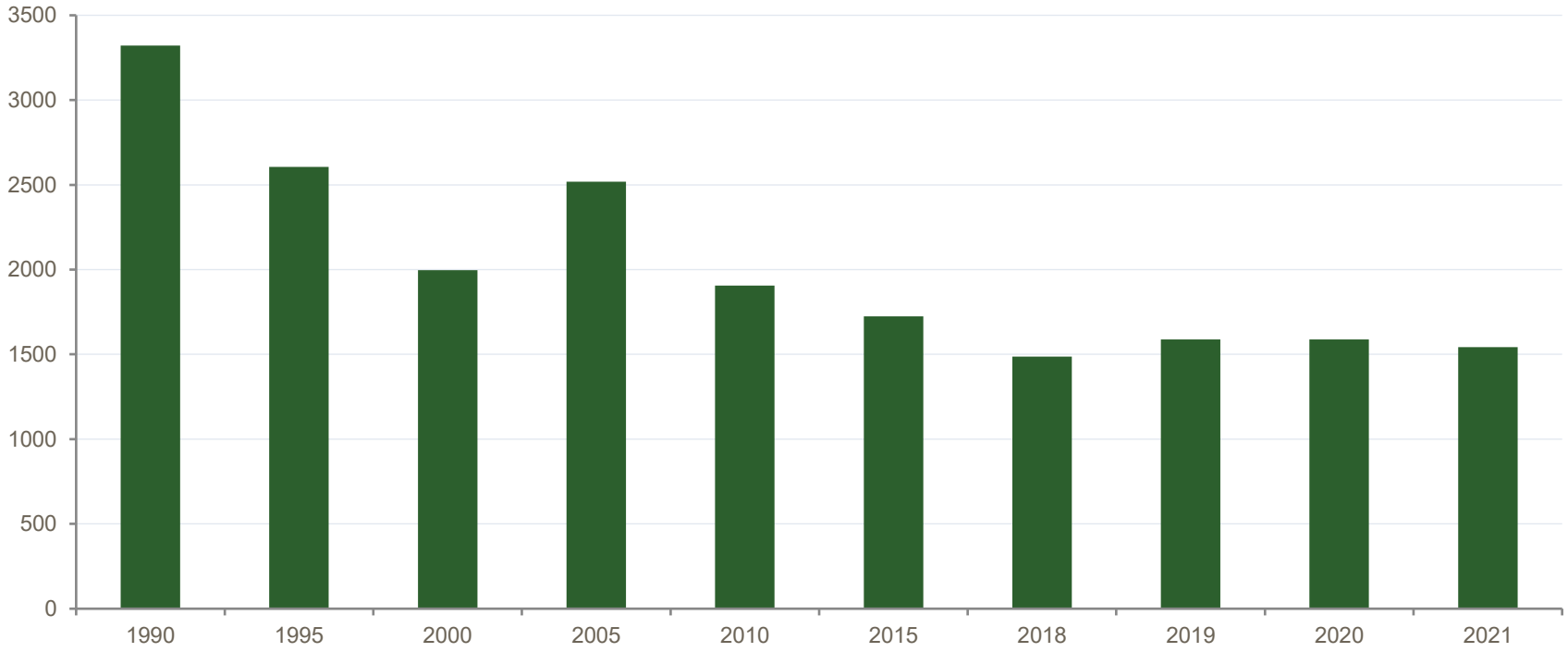
tonnes cotton
production (2021)

6.0M

tonnes wheat
production (2021)

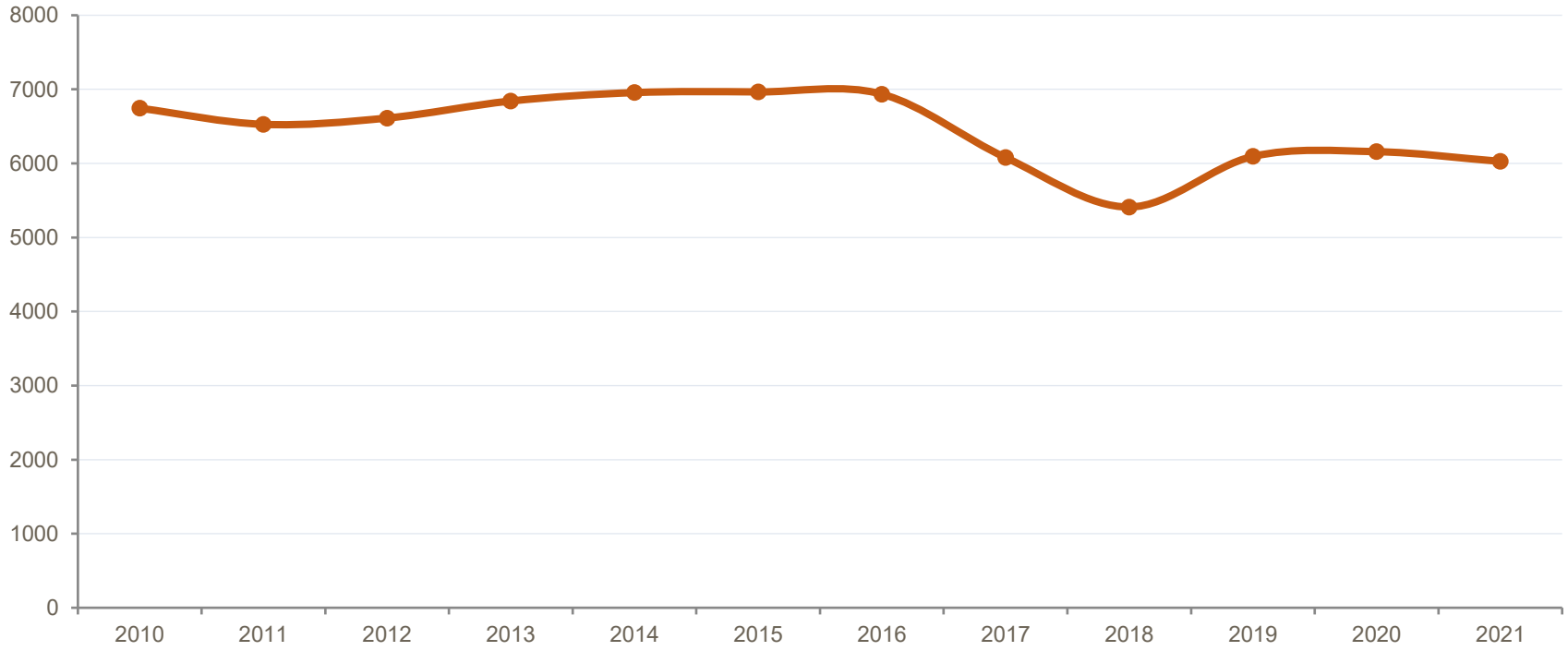
Source: stat.uz (2024)

Cotton Production Trends (1990–2021)



Cotton output declined ~55% since 1990 due to policy shifts, water scarcity, and crop diversification reforms.

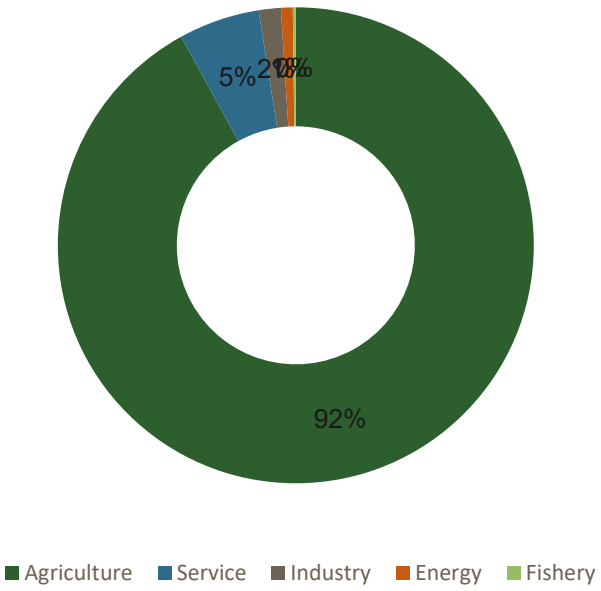
Wheat Production Trends (2010–2021)



Wheat production dropped in 2017–2018 due to water shortages, then partially recovered. Self-sufficiency target: ~7 mln tonnes.

Water Use & Agricultural Employment

Water use by sector



Employed in agriculture (thousands)

Source: stat.uz (2024)

Key Environmental & Agricultural Challenges

Critical issues facing sustainable development in Uzbekistan

Water Scarcity & Irrigation Challenges

Irrigation dependency

90%+ of agriculture relies on irrigation; water use efficiency is only 30–35% due to unlined canals and flood methods

Secondary salinization

Over 50% of irrigated land affected; directly linked to poor drainage and excessive water application

Transboundary tensions

Upstream dams (Rogun, Kambarata) reduce downstream flow predictability for Amu Darya & Syr Darya

Climate impact

10–15% projected decline in glacier-fed river discharge by 2050; increasing drought frequency

Discussion: How can IWRM frameworks address the water-energy-food security nexus?

Soil Degradation & Desertification

50%

of irrigated land is moderately to severely salinized

722K ha

affected by irrigation erosion across the republic

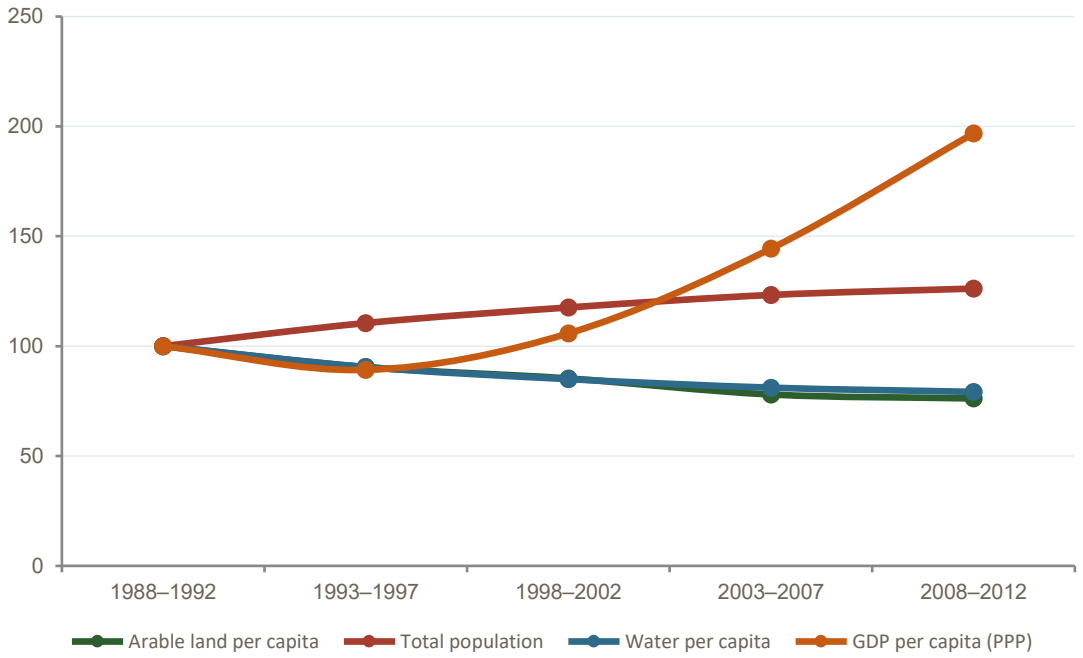
40–150M t

salt-dust aerosols from dried Aral Sea bed annually

Cotton monoculture depleted soil organic matter to 0.5–1.0%. Excessive mineral fertilizer (250–300 kg/ha) disrupted soil microbiome. Yield losses in cotton reach 30–40% on salinized land.

The dried Aral Sea bed is now one of the world's largest sources of toxic dust, affecting health across Karakalpakstan, Khorezm, and Bukhara.

Land Scarcity & Competing Uses



Key Insights

- Per capita arable land declined from 0.23 ha (1991) to ~0.11 ha (2024)
- Population grew 26% while water resources per capita fell 21%
- GDP growth decoupled from natural resource availability
- Urbanization converts 10–15K ha of farmland annually

Key concept: Ecosystem services valuation (ESV) for optimal land-use allocation

Agricultural Modernization Gap

Yield Comparison: Uzbekistan vs. Global Leaders

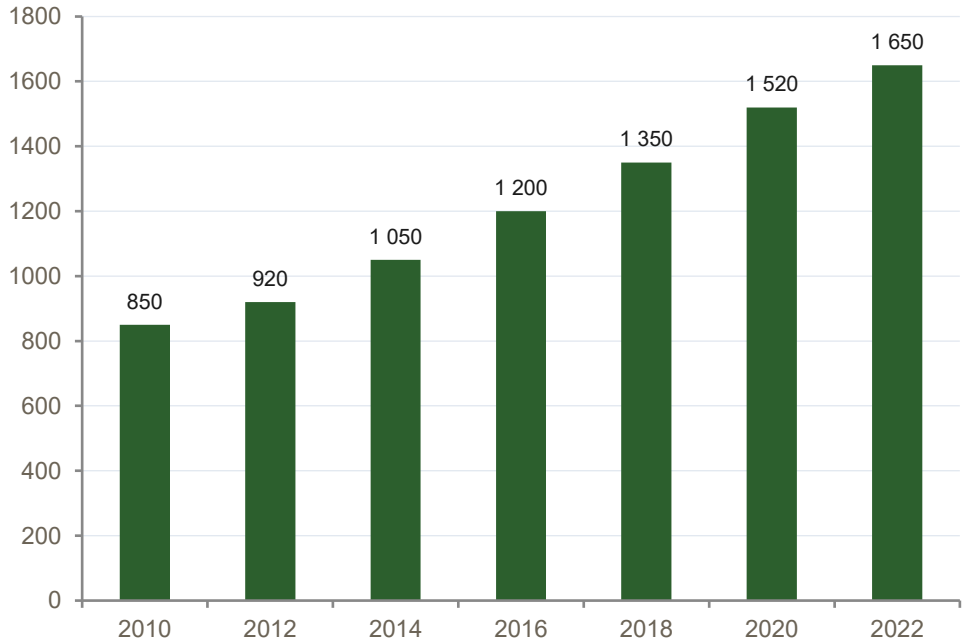
Crop	Uzbekistan	Turkey / China	Gap
Cotton (raw)	2.5–2.8 t/ha	4–5 t/ha	**–40–50%**
Wheat	4.5–5.0 t/ha	7–8 t/ha	**–35–40%**
Fruits/Vegetables	15–20 t/ha	30–45 t/ha	**–40–55%**

Farm consolidation (2019+) created clusters but many operators lack agronomy expertise. Extension services remain underfunded.

Drivers: limited precision agriculture, aging machinery, weak research-to-farm linkages, insufficient extension services.

Discussion: What mechanisms can accelerate technology transfer from research to farm practice?

Protected Areas & Biodiversity Threats



Biodiversity Threats

- Aral Sea desiccation eliminated endemic fish species and wetland habitats
- Overgrazing on 71% pastureland causing rangeland degradation
- Agricultural runoff (pesticides, fertilizers) polluting river ecosystems
- Habitat fragmentation from infrastructure expansion

Source: State Committee on Ecology, stat.uz

Policy Recommendations for Sustainable Development

Evidence-based pathways for Master-level research and policy analysis

I. Economic Instruments for Resource Efficiency

Volumetric water pricing

International evidence (Australia, Israel) shows 15–25% efficiency gains when water is priced at marginal cost

Market liberalization

Cotton and wheat market reforms as prerequisite for effective resource pricing and land market development

Fiscal rebalancing

Shifting from land-area-based taxation to water-consumption charges to incentivize conservation

Investment incentives

Drip irrigation (ROI in 3–5 years for horticulture) and laser leveling can reduce water use by 30–50%

II. Institutional & Technical Strategies

IWRM & WUAs

Strengthen Water User Associations for participatory governance

Conservation Agriculture

Crop rotation, reduced tillage, cover crops for soil health

SDG & NDC Alignment

National Action Plans linked to Paris Agreement commitments

Green Finance & PPP

Climate finance mechanisms, public-private partnerships

Crop Diversification

Shift to high-value horticulture, reduce cotton dependency

Cold Chain & Extension

Post-harvest modernization, digital agriculture, research linkages

Thank You!

Questions & Discussion

Discussion Topics for Master Students:

- How can Uzbekistan balance cotton export revenue with water conservation?
- What role can ecosystem services valuation play in land-use planning?
- Compare IWRM implementation challenges in Uzbekistan vs. other arid countries

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