Socio-economic assessment of existing forest and agroforestry production systems for fruit and nut production in Kyrgyzstan – A field study using Monte-Carlo simulation analysis

Authors/Co-authors:

Md Sofiullah[a]
Email: md.sofiullah@ hsrw.eu

Jannike van Bruggen[b]
Email: jannike.vanbruggen@hsrw.eu

Dietrich Darr[c,d]
Email: dietrich.darr@hswt.de

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[a] PhD student, Scientific Research Associate, Faculty of Life Sciences, Rhine-Waal University of Applied Sciences (HSRW), Kleve, Germany

[b] Project coordinator, SUFACHAIN, Scientific Research Associate, Faculty of Life Sciences, Rhine-Waal University of Applied Sciences (HSRW), Kleve, Germany

[c] Professor for Sustainable and resilient farming and food systems, Faculty of Agriculture, Food, and Nutrition, University of Applied Sciences Weihenstephan-Triesdorf, Freising, Germany

Outline

- **Research gap**

- **Field study overview**

- **Methodology**

- **Results**

Research gap

- Kyrgyzstan's agricultural production systems:

  - Economic volatility

  - Heightened vulnerability to climate shocks

  - Climate-driven resource constraints

  - Increasing water resource constraints

  - Irrigation challenges

  - Transboundary conflicts

  - Posing significant risks on agricultural sustainability and rural livelihoods

- **Agroforestry systems (AFS) remain understudied in the region**

Net benefits of Agroforestry systems (AFS)

Maximum production of ecosystem services (primary output, soil, water, air, carbon, etc.)

Strengthens rural economies, smallholder enterprise development

Expands employment opportunities, food security

Promotes environmental sustainability

Problem: Lower productivity & profitability vs. high-input agriculture

Field study overview

- **Study locations**: Arslanbob Aiyl Aimak, Jalal-Abad, Batken (Kyrgyzstan)

- **Study time period**: November 2024 – January 2025

- **250 smallholder farming household surveys** conducted via enumeration team

  - Open Data Kit (ODK) Collect Survey application, Snowball sampling method

- **Focus Group discussion (FGD)** (2 for each region)

- **Expert Interview (EI)** (2 for each region)

- **SUFACHAIN Project: Promoting sustainable land management through product, process and SME development in NTFP and agroforestry value chains in Central Asia**
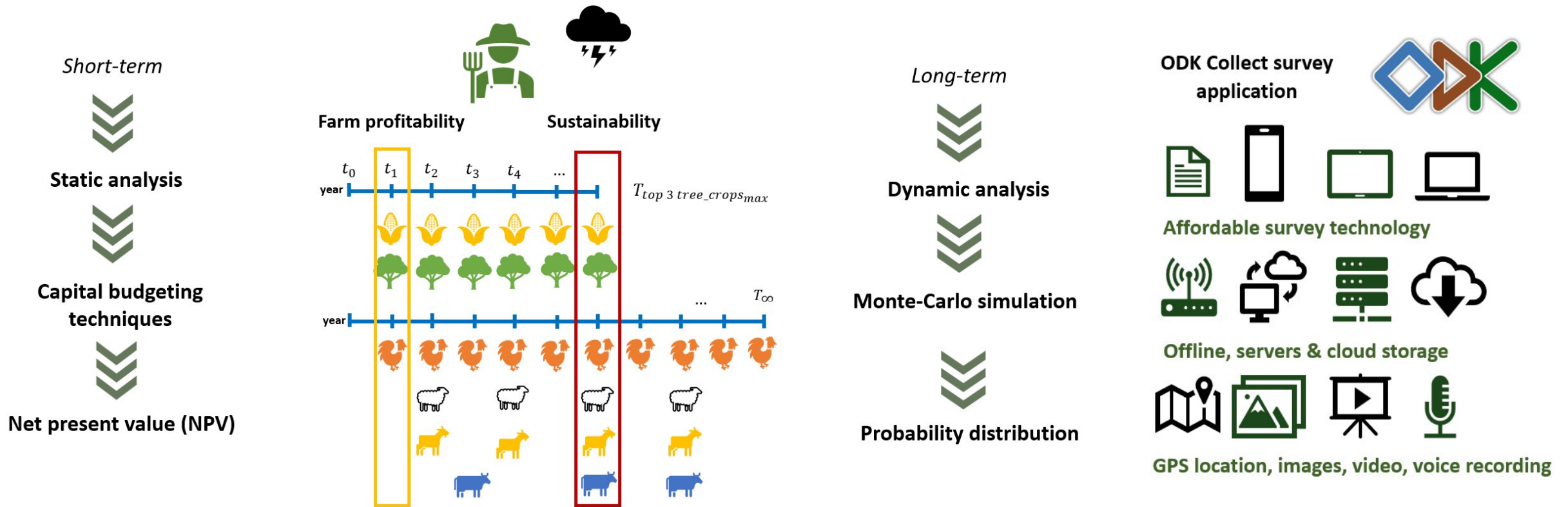

Source: Asia - Detailed | MapChart

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Methodology

Can Agroforestry Sustain Farm Profitability Under Climate Shocks in Kyrgyzstan?

Short-term

Static analysis

Capital budgeting techniques

Net present value (NPV)

Farm profitability · Sustainability

$T_{top\ 3\ tree\_crops_{max}}$

T_{∞}

Long-term

Dynamic analysis

Monte-Carlo simulation

Probability distribution

ODK Collect survey application

Affordable survey technology

Offline, servers & cloud storage

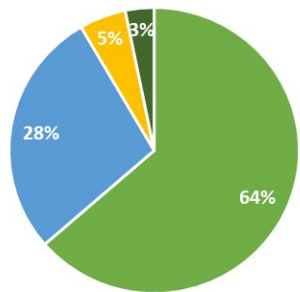GPS location, images, video, voice recording
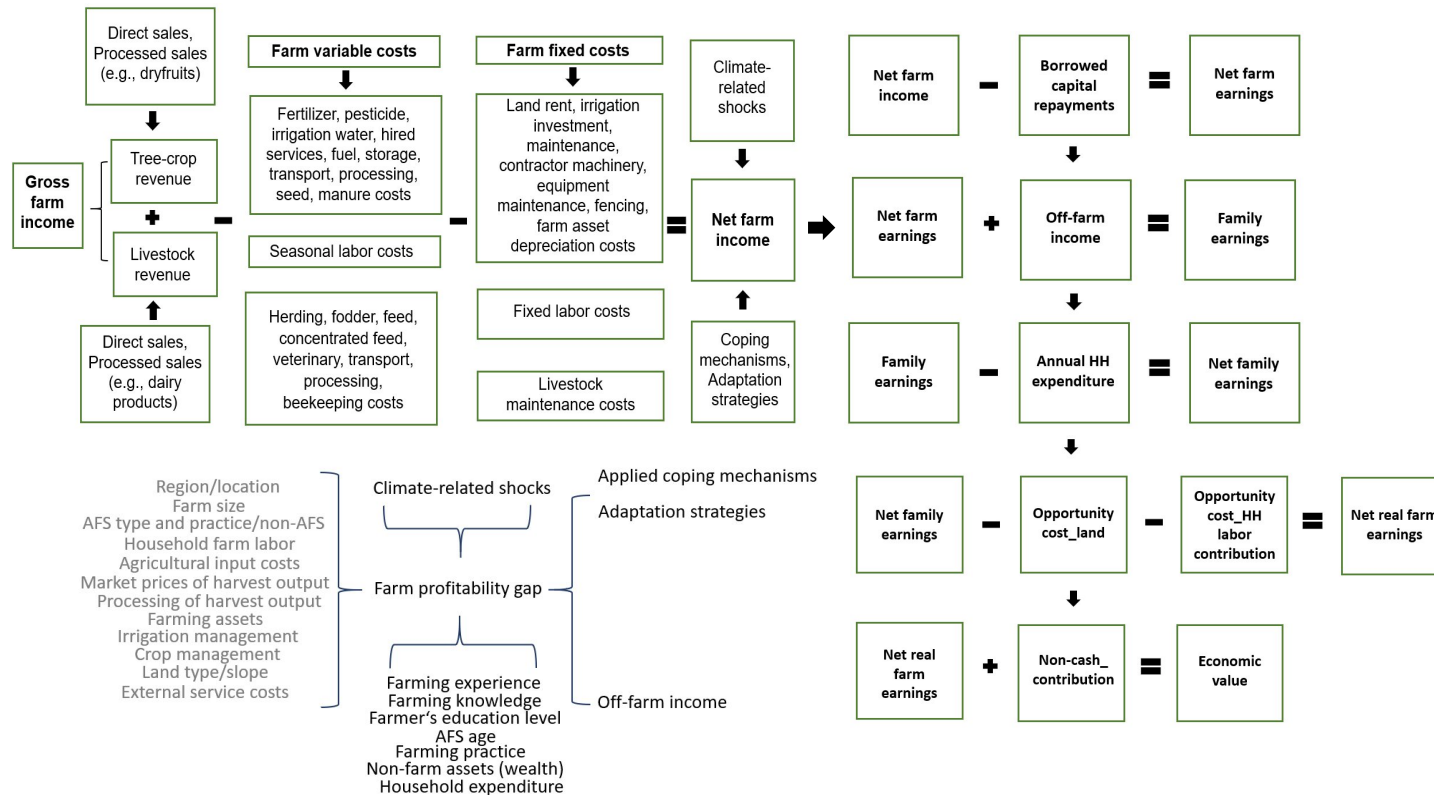
- Socio-economic farm and household data

- Farmers' production and sales decision-making (heterogeneity)
  - Farm production
  - Household consumption
  - Direct sales
  - Processed sales
  - Price selection based on sales location
  - Crop and water management, practices

- Biophysical data (trees-crops)

- Opportunity costs of land and family labor contribution, household expenditure distribution

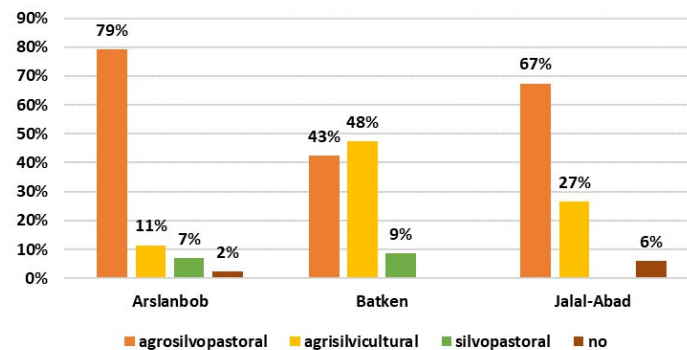- Findings – subject to change!

Results
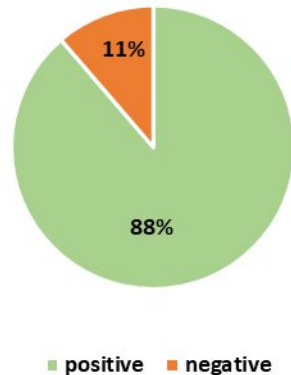
Agricultural land type (% of total land in region)

- Cultivated field
- Kitchen garden
- Fallow
- Fruit orchard
- Hayfield
- Pasture
- Forest tree plantation/woodlot
- Agroforestry

AFS type

agrosilvopastoral · agrisilvicultural · silvopastoral · no

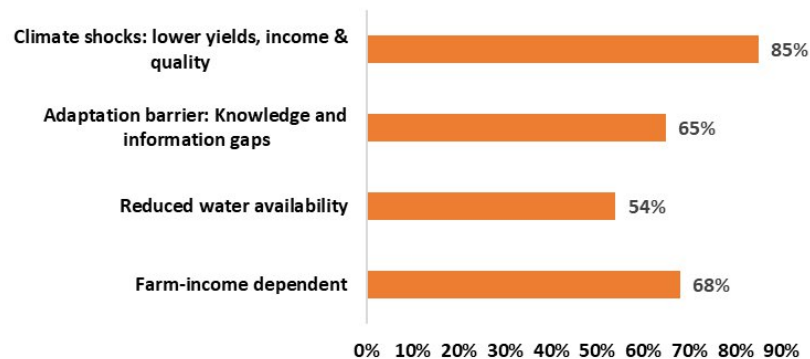AFS type by region

agrosilvopastoral · agrisilvicultural · silvopastoral · no
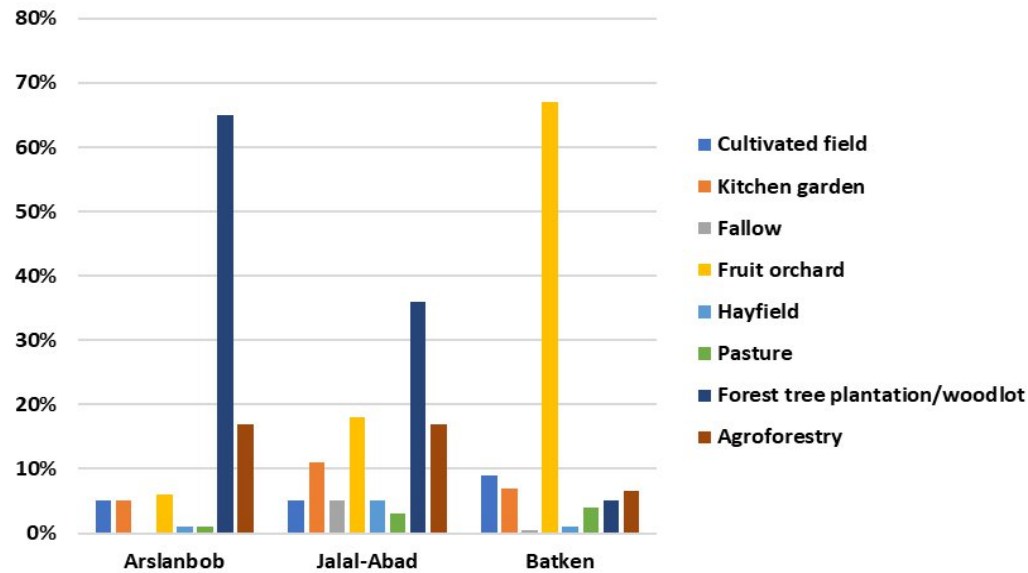
- Sample: 64% agrisilvopastoral systems, 28% agrisilvicultural systems
- 65 – 100% of farm income data collected (as reported by the respondents)
- Non-parametric tests:
  - Kruskal-Wallis test
  - Wilcoxon Signed-Rank Test
  - Mann-Whitney U test
  - Group-wise descriptive statistics
- **Respondent:** Household head (**81%** of respondents)
- **HH head gender:** Male (**89%** of respondents)
- **Education:** Secondary-level (**63%** of respondents)
- **Farm income dependent:** Half to Most from farm (**68%**)
- **Family contribution in farming activities:** Yes (**80%** of respondents)
- **Farm experience:** 2 – 50 years (mean: 20 years)
- **Cultivated land (mean):** 1.07 hectares
- **Land tenure:** Own land (**40%** of respondents)
- **Off-farm income:** Yes (**87%** of respondents)
- **AFS practices:** Alleycropping and Homegardens

Farm Profitability

Net farm income (% of total respondents)

- 11%
- 88%
- ■ positive ■ negative

Key challenges and dependencies (% of total respondents)

- Climate shocks: lower yields, income & quality — 85%
- Adaptation barrier: Knowledge and information gaps — 65%
- Reduced water availability — 54%
- Farm-income dependent — 68%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90%

- **Positive net farm income: 88%** of respondents

- **Top income-generating crops and livestock:**
  - Apricot, walnut, maize, potato, peach, tomato, cherry, poplar, alfalfa
  - Cattle, sheep, poultry

- **AFS age:** 2 – 35 years (mean: 12 years), higher net farm income

- **More than 80%** of households have a kitchen garden

- On average, **tree-crop production non-cash contribution** to household consumption is **12%** of net farm income

- **Agrisilvopastoral systems**, higher net farm income compared to agrisilvicultural systems

- **Land tenure** linked to farm profitability

- More **years of farm experience, secondary education, personal experience** associated with higher net farm income

- **Intercropping**, pruning households have higher net farm income
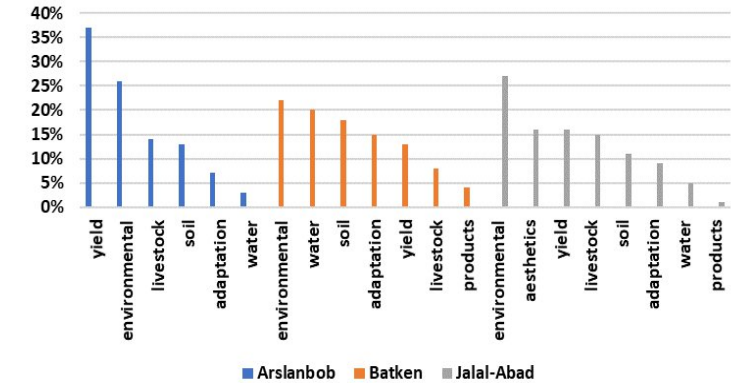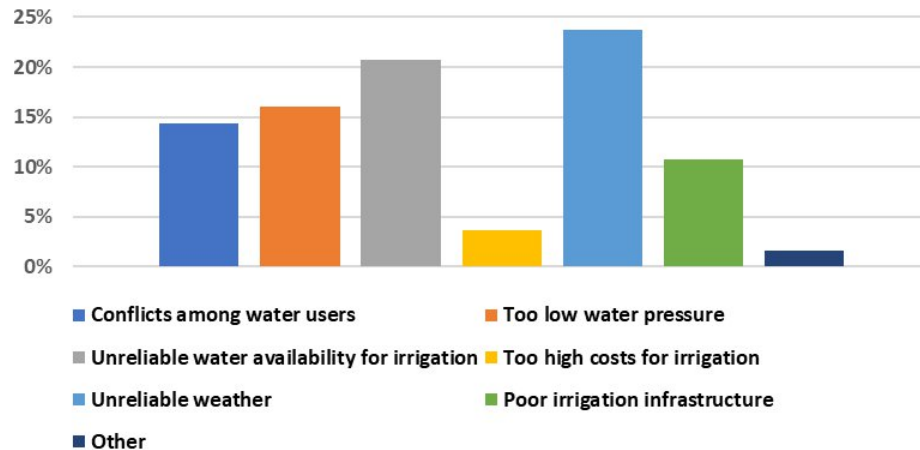
Climate Shocks

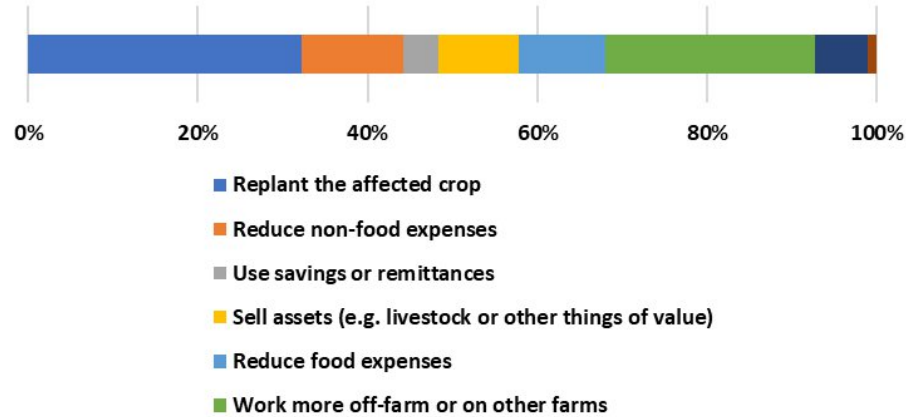Climate shocks by type
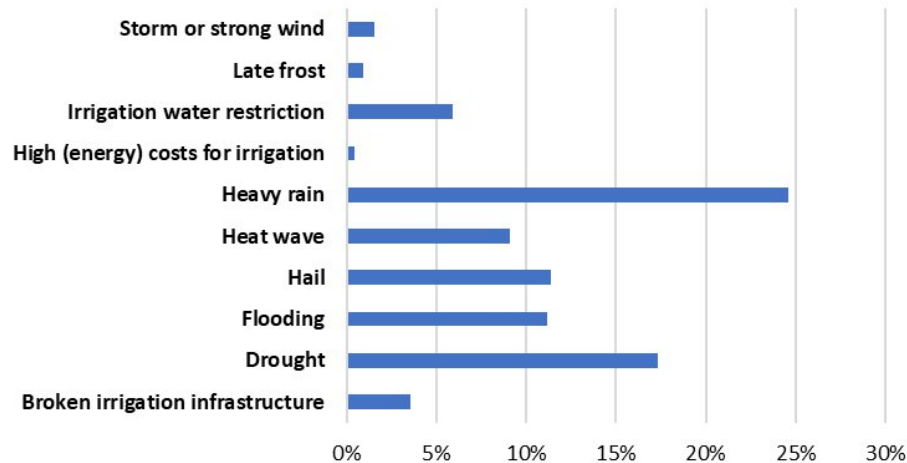
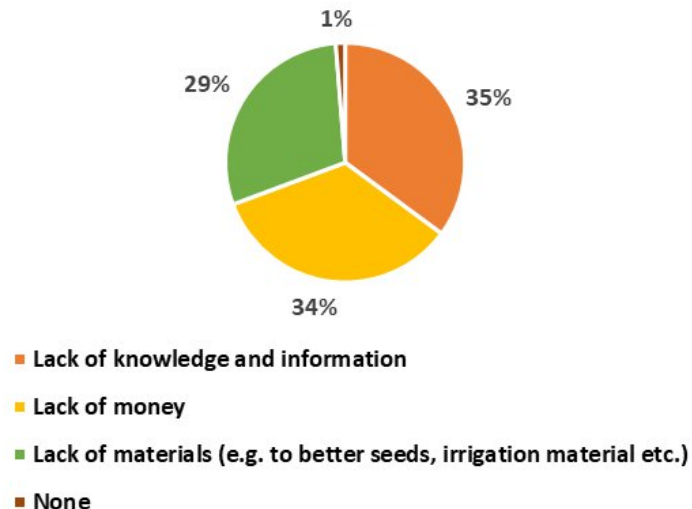Climate shocks impact
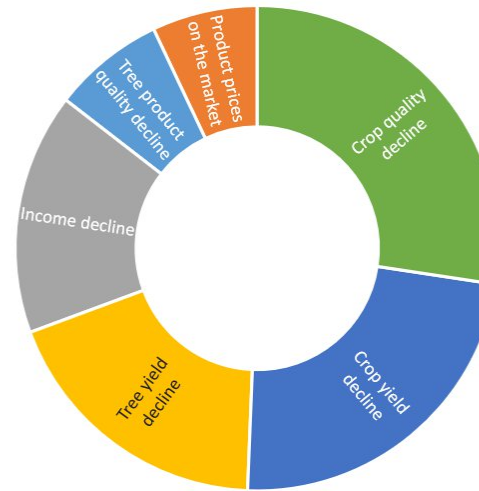
AFS reasons

Irrigation challenges

- **Most commonly reported climate shocks:** heavy rain, drought, flooding, heatwave, drought
- **Irrigate: 95%** of respondents
- **Irrigation challenges:** Unreliable weather, irrigation water availability, low pressure conflicts among water users (**increased water stress**)
- **Significant negative impact of more frequent climate shocks on farm income (yields, prices, quality)**
- **Water availability future expectations:** less water (**54%** of respondents)
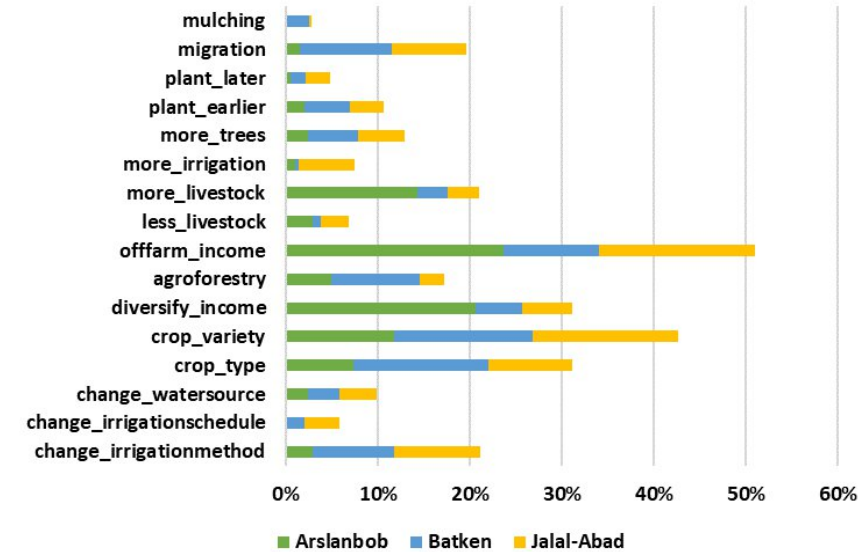
Coping and adaptation strategies

Coping strategies

- **Coping strategies:** dominated by replanting, cutting expenses (non-food reduction, migration to off-farm work)
- More severe **shocks leads lower net farm income, more coping strategies**
- **Adaptation strategies:** off-farm income, efforts focus on crop changes, water management
- **Adaptation is limited mainly by knowledge, money, and access**

Outlook

- Agroforestry improves productivity and resilience, but adoption is limited by irrigation constraints, climate-related shocks, and knowledge gaps.

  - Diversifies income sources

  - Reduces losses from climate shocks

  - Supports household food security

- Further research to evaluate profitability and the impact of climate shocks:

  - Household labor contribution, opportunity cost of land, household consumption patterns

  - Biophysical traits of tree–crop species

  - Cost and price dynamics in profitability assessment

  - Identifying effective management practices, agroforestry arrangements that drive higher profitability and resilience

- AFS adoption requires targeted support; institutional, technical, economical support

- Research: proper documentation and farmer mobilization

Thank you!

Contact us:
Md Sofiullah
Email: md.sofiullah@hsrw.eu

Jannike van Bruggen
Email: jannike.vanbruggen@hsrw.eu

Dietrich Darr
Email: dietrich.darr@hswt.de

Rhine-Waal University of Applied Sciences
Marie-Curie-Str. 1
47533 Kleve
Germany
+49 2821 80673 9823

sufachain@hochschule-rhein-waal.de

www.sufachain.org

www.lifeinkyrgyzstan.org