# Nutrition-sensitive agricultural diversification and dietary diversity: Panel data evidence from Tajikistan

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# Outlines

- **Background**
  - Roles of agriculture on nutrition improvement
  - Home production of food items within semi-subsistence contexts
  - Limited micro-evidence for semi-subsistence households in former socialist countries

- **Objectives:** to assess
  - Linkage between home production on food items and food/nutrition security, poverty reduction among semi-subsistence households in Tajikistan

- **Empirical approach**
  - Khatlon province, Tajikistan (agriculture-based, high poverty province)
  - Panel data
  - Standard model
    - Fixed-effects instrumental variable model
    - Difference-in-difference propensity-score matching (DID-PSM)
  - **"Incentive-based model"** within subsistence economy context
    - Lee-Maddala-Björklund-Moffitt (LMBM) model with Correlated Random Effects (LMBM-CRE)

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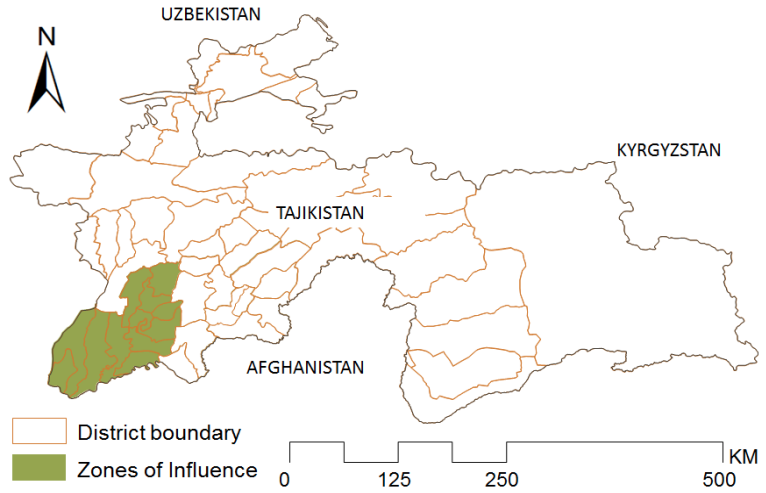
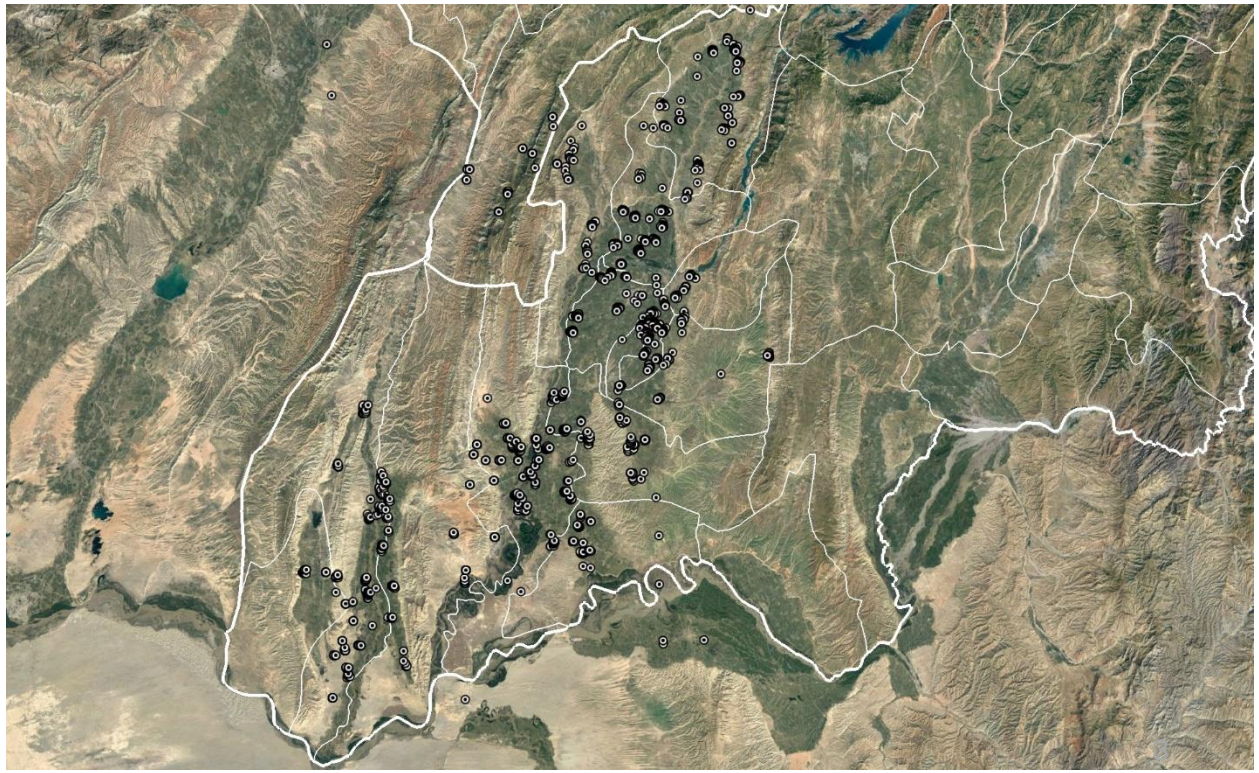
# Survey locations: Khatlon Province, Tajikistan

- 1,598 panel households (2015 / 2023)
- 322 panel women of reproductive age (15-49 years old)
- 12 Raions (districts) from USAID Feed-the-Future (FTF) Zone of Influence
- 2015: USAID FTF Mid-line survey
- 2023: Follow-up survey
- Survey periods: February – March



# Empirical approaches

**A. Associations between *agricultural production practices* and *food/nutrition security, poverty***

1. **Agricultural production practices**
   - Diversification
   - Land productivity (Yield)
   - Labor productivity (Production per capita)
2. **Methodologies**
   a) **Instrumental variable regression**, instrumenting agricultural production practices by
      - Farm size
      - Agricultural capital
   b) **Difference-in-Difference Propensity Score Matching**
      - Binary indicator of various agricultural production practices (below or above sample median)

**B. "Incentive-based model"** within subsistence economy context

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# B. "Incentive-based model" within subsistence economy context

- Lee (1979) – Maddala (1983) – Björklund & Moffitt (1987) framework
- Revisited by Eisenhauer, Heckman & Vytlacil (2015) for impact evaluation

$$\mathrm{U}\left(Y_{it}^{0} + \alpha_{it} - \phi_{it}\right) > \mathrm{U}\left(Y_{it}^{0}\right)$$

$\alpha_{it}$: benefits

$\phi_{it}$: costs

$$Y_{it} = X_{it}\beta + Z_{it}\delta + CRE_i + \varepsilon_{it} + u_{it} \quad \text{if } R_{it} = 1 \text{ (Agricultural diversification, land/labor productivity is above sample median)}$$

$$Y_{it} = X_{it}\beta + CRE_i + \varepsilon_{it} + u_{it} \quad \text{if } R_{it} = 0$$

$R_{it} = 1$ if $R_{it}^{*} > 0$;

$R_{it} = 0$ otherwise

$$R_{it}^{*} = Z_{it}\delta - W_{it}\eta + CRE_i + u_{it} - v_{it}$$

Capture how expected returns induce agricultural intensification ("incentive")

$$\alpha_{it} = Z_{it}\delta + CRE_i + u_{it} \quad (\alpha_{it} \text{ is unobserved})$$

$$\phi_{it} = W_{it}\eta + CRE_i + v_{it} \quad (\phi_{it} \text{ is unobserved})$$

Identify factors that affect (unobserved) benefits and costs of adopting particular agricultural production characteristics

Estimate this by Lee (1979)'s "*two stage probit analysis*" method

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# Outcomes and agricultural production characteristics of interests

## Outcomes

| Categories | Unit | Measurement |
|---|---|---|
| Dietary diversity | Household | 12 food groups (7-day recall) |
| | Women | 10 food groups (1-day recall) |
| Poverty | Household | USD 3.65 per capita per day (constant 2017 USD, PPP) |
| Household hunger scale | Household | 0 = no hunger; 6 = most severe hunger |
| Subsistence food consumption | Household | Consumption × Imputed price |

## Agricultural production characteristics (household level)

| Categories | Measurements (household level) |
|---|---|
| Diversification | Number of food groups produced |
| Land productivity | Total production value per cultivated area |
| Labor productivity | Total production value per capita |

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# Explanatory variables – household level model

| Categories | Variables |
|---|---|
| Household demographics | • Age / gender of primary respondent<br>• Household size by age group, gender<br>• Members living away from home for at least 6 months |
| Human capital | • Education (average among working age household members) |
| Agroecological variables | • historical temperature, rainfall, soil, hydrological conditions (proximity to the nearest major rivers, groundwater depth), elevation, terrain ruggedness, and the local land-share of pasture |
| Wealth | • Durable assets<br>• Livestock<br>• Housing conditions (improved materials used for flooring, exterior walls, access to gas for cooking) |
| Sanitary and hygienic conditions | • Improved sources of drinking water, and improved sanitation system<br>• Garbage collection, disposal systems, centralized sewage system |
| Access to markets | • Distances to food market (state stores, private store, food market/bazaar, livestock market/bazaar, restaurant, café) |
| District (Raion), year dummy | |

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# Additional explanatory variables – Individual women's model

## Women

| Categories | Variables |
|---|---|
| Demographics | Age of women |
| Human capital | Education level of women |

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# Additional explanatory variables: Decomposing unobserved benefits and costs in “Incentive-based model”

| Categories | Variables |
|---|---|
| Factors potentially affecting the benefits but not costs | • Ownership of fridge, freezer or microwave oven (= affect how the harvested crops are stored and processed effectively)<br>• Output price of crops produced |
| Factors potentially affecting the costs but not benefits | • farm size<br>• agricultural capital |

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# RESULTS

# Dietary diversity

| Outcomes | Ag production practices | Instrumental variable regression | | Propensity score matching | |
|---|---|---|---|---|---|
| | | All | Remote | All | Remote |
| **Household dietary diversity score** (*count*) | Diversification (*count*) | **0.258*** ** | **1.142** ** | **0.751*** ** | **1.112*** ** |
| | Land productivity (*natural log*) | **0.772*** | **1.245** ** | **0.340** ** | **0.525** ** |
| | Labor productivity (*natural log*) | **0.850*** | **0.096*** ** | **0.705*** ** | **0.985*** ** |
| **Women's dietary diversity score** (*count*) | Diversification | **0.122** ** | **0.360*** ** | 0.206 | **0.986*** |
| | Land productivity | 0.022 | **0.131*** ** | NA | NA |
| | Labor productivity | 0.031 | **0.154*** | **0.537*** | **1.139** ** |

⇒ Broadly positive linkages between greater diversification, land and labor productivity, and dietary diversity score

⇒ Particularly strong linkages in remote areas

# Poverty, hunger scale, subsistence food consumption

| Outcomes | Ag production practices | Instrumental variable regression | | Propensity score matching | |
|---|---|---|---|---|---|
| | | All | Remote | All | Remote |
| **No poverty** (*binary*) | Diversification (*count*) | **0.026*** ** | **0.023*** ** | **0.056*** | **0.075*** |
| | Land productivity (*natural log*) | **0.019*** | **0.032** ** | **0.151*** ** | **0.122** ** |
| | Labor productivity (*natural log*) | **0.026** ** | **0.013*** | **0.054*** | **0.077** ** |
| **Less hunger** (*reverse of household hunger scale*) | Diversification | **0.026*** | **0.551** ** | **0.114*** | **0.264** ** |
| | Land productivity | 0.026 | **0.526*** | 0.113 | **0.281*** |
| | Labor productivity | **0.026** ** | **0.026** ** | **0.250*** ** | **0.307*** ** |
| **Subsistence food consumption** (*natural log, standardized*) | Diversification | **0.672*** ** | **0.542** ** | **0.957*** ** | **0.994*** ** |
| | Land productivity | **0.892** ** | **0.867** ** | 0.110 | **0.223*** |
| | Labor productivity | **0.823** ** | **0.997** ** | **0.693*** ** | **0.700*** ** |

⇒ Broadly positive linkages, particularly remote areas
⇒ Key contribution of subsistence consumption of home-produced food items

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# Incentive-based model

| Key associated factors | Returns from agricultural diversification<br>Returns from women's dietary diversity score | | Costs of agricultural diversification |
|---|---|---|---|
| | (including returns on HDDS) | (including returns on WDDS) | |
| Durable asset | **0.115**$^{***}$ | –0.004 | –0.002 |
| Improved sanitation | **–0.520**$^{*}$ | **–0.073**$^{*}$ | –0.032 |
| Garbage collection | –0.163 | **–0.270**$^{**}$ | –0.128 |
| Livestock assets | 0.123 | –0.064 | **–0.037**$^{**}$ |
| Distance to food market | **0.173**$^{*}$ | 0.007 | **0.018**$^{***}$ |
| Farm area with use rights | 0.207 | –0.116 | **0.095**$^{**}$ |
| Own refrigerator | **0.579**$^{*}$ | –0.075 | |
| Inverse Mills ratio | –1.168 | **0.265**$^{**}$ | |
| Agricultural capital | | | **–0.047**$^{**}$ |

⇒ (Unobserved) returns from agricultural diversification differ across households and women, given their characteristics

⇒ More agricultural capital lowers (unobserved) costs

| | HDDS | WDDS |
|---|---|---|
| Returns from agricultural diversification (on dietary diversity) | **0.014*** | **0.040**** |
| | (0.008) | (0.019) |

⇒ Higher returns from agricultural diversification induces greater agricultural diversification (i.e., incentive-driven decision on agricultural diversification)

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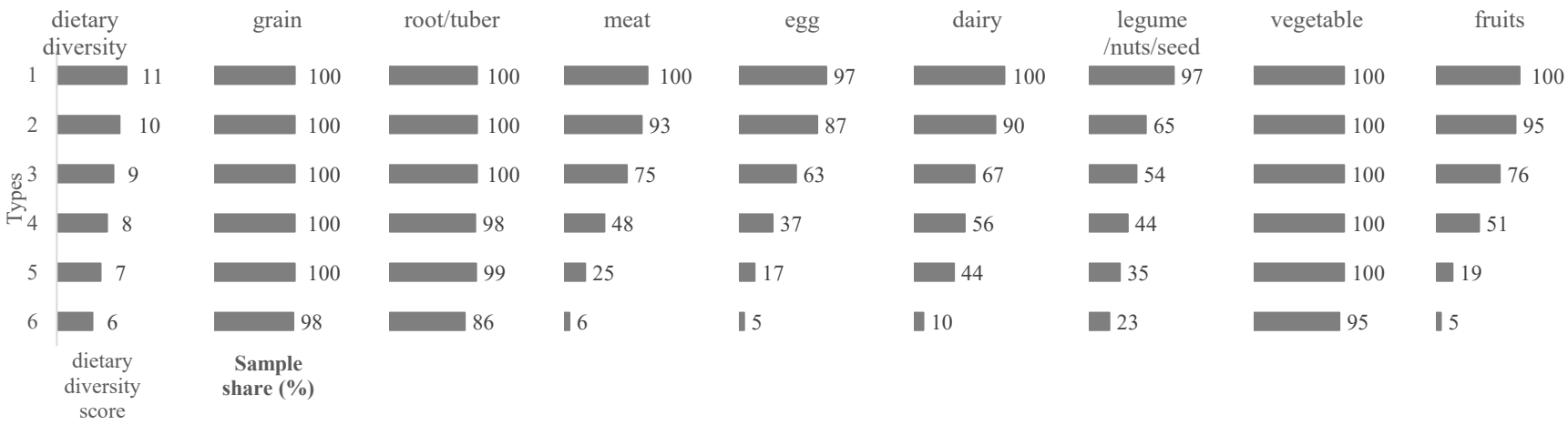
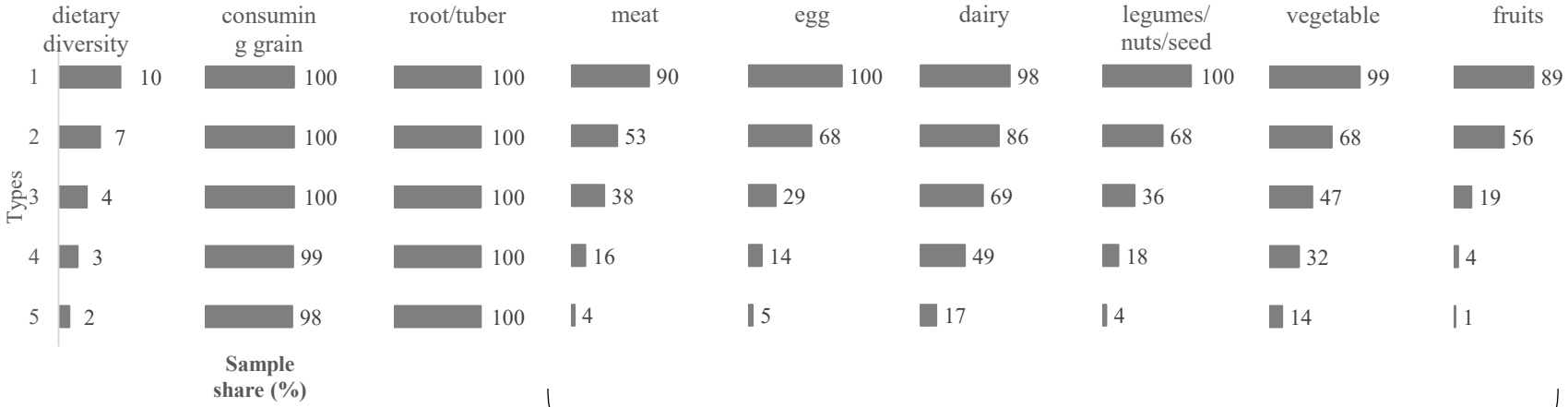
# Dietary diversity and specific food groups (typology)

Household level




Individual women level




Major drivers of dietary diversity

# Strong linkages at food-group levels

| Outcomes | Ag production practices (whether growing) | Instrumental variable regression | | Propensity score matching | |
|---|---|---|---|---|---|
| | | All | Remote | All | Remote |
| **Household dietary diversity score (*count*)** | Vegetables | –0.024 | –0.034 | 0.009 | 0.013 |
| | Fruits | **0.353*** ** | **0.566*** ** | **0.090** ** | **0.173*** ** |
| | Legumes / nuts | **0.370*** | **0.651*** ** | **0.230*** ** | **0.249*** ** |
| | Dairy products | **0.776*** ** | **0.634*** ** | **0.572*** ** | **0.494*** ** |
| | Eggs | **0.331** ** | **0.863*** ** | **0.517*** ** | **0.507*** ** |
| **Women's dietary diversity score** | Vegetables | 0.070 | **0.311*** | 0.043 | **0.265*** |
| | Fruits | 0.149 | **0.878*** ** | **0.121** ** | **0.156** ** |
| | Legumes / nuts | **0.345*** ** | **0.308*** | 0.059 | **0.680*** |
| | Dairy products | **0.879*** ** | **0.589** ** | **0.669*** ** | **0.466*** ** |
| | Eggs | –0.221 | 0.079 | **0.283*** | **0.206*** ** |

=> Significant linkages between home-production and consumption at food group levels

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# Conclusions

- In Khatlon province, Tajikistan, home-production of food item remains important for dietary diversity (household level as well as for individual women of reproductive age)
  - Diversification, land and labor productivity growth in food production
- Home production of food items also beneficial in poverty / hunger reduction
- Potential returns to home production of food items, which are unobserved, vary across households
- Higher returns incentivize households to extend agricultural diversification

  => Incentive-based decision-making important for semisubsistence households in former socialist countries
- Improved knowledge on the benefits of dietary diversity potentially important for stimulating agricultural diversification and productivity growth among these households

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# Thank you !

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