Agriculture-nutrition linkages in Tajikistan: Selected insights from recent IFPRI studies

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Outlines

- Background
- Conceptual framework
- Paper 1
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  - Results
- Paper 2
  - Methodology
  - Results
- Conclusions

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ORIGINAL ARTICLE

AGRICULTURAL ECONOMICS

WILEY

Agriculture–nutrition linkages with heterogeneous, unobserved returns and costs: Insights from Tajikistan

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Abstract

Agriculture–nutrition linkages (ANLs) have been increasingly investigated in the literature. However, nutritional returns and costs of household agricultural production practices (APPs) in semisubsistence settings are poorly understood. We fill these knowledge gaps using pooled cross-section data sets in Tajikistan, where semisubsistence farming and undernutrition coexist despite relatively good agricultural infrastructure and education systems. Agricultural diversification, yield enhancement, production expansion are positively associated with various nutritional outcomes, particularly in areas with poor food market access. Decomposition exercises suggest that nutritional returns and costs of these APPs vary across households, and the adoption of APPs is driven by the expected nutritional returns. In Tajikistan, improving nutrition through household ANLs requires growing the smallholder agricultural sector in multiple dimensions, including diversification, intensification, and expansion, while also understanding better the pathways of ANLs and addressing bottlenecks at appropriate stages of such pathways.

KEYWORDS

agriculture–nutrition linkage, anthropometrics, dietary diversity, market access, Tajikistan, two-stage probit analysis

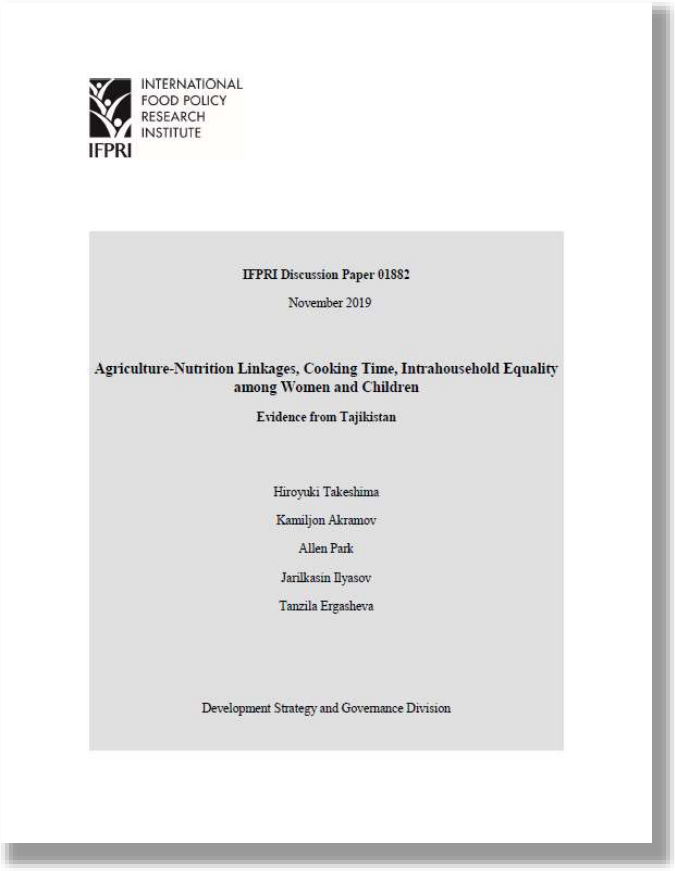
JEL CLASSIFICATION

O13, O15, Q12, Q18

1 | INTRODUCTION

Agriculture–nutrition linkages (ANLs) in developing countries have been increasingly investigated in the literature (Jones, 2017; Ruel, Quisumbing, & Balagamwala, 2018). The nonseparability of production and consumption decisions by rural farm households (LaFave & Thomas, 2016; Le, 2010; Singh, Squire, & Strauss, 1986) reinforces such ANL at the household level. Conversely, the proximity to food markets mitigates such nonseparability, and weakens the household-level ANL (Hirvonen & Hoddinott, 2017).

If ANL is present due to such nonseparability and the semisubsistence nature of the farm households, the nutritional returns to and costs of particular agricultural production practices (APPs) may become less observable. These returns and costs depend more on nonmarket features; marginal utility derived from agricultural production, and the shadow prices of inputs, rather than observable prices for agricultural outputs and inputs in the markets. If these returns and costs vary across households, the nutritional returns to and costs of APPs also become heterogeneous across households. Furthermore, these unobserved returns and costs can be associated in



INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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IFPRI Discussion Paper 01882

November 2019

Agriculture-Nutrition Linkages, Cooking Time, Intrahousehold Equality among Women and Children

Evidence from Tajikistan

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Background

- **Malnutrition** in low-income countries including Tajikistan
- **Food-based approach** to complement medical approach
- **Nutrition-sensitive approach** to complement nutrition-specific approach
- **Agriculture-nutrition linkage**
  - Recognized as important (World Bank 2007; FAO 2015; Ruel et al. 2018; Fan et al. 2019)
  - However, knowledge gap still large, including Tajikistan

- **Richer sets of evidence needed for various aspects of agriculture-nutrition linkage**

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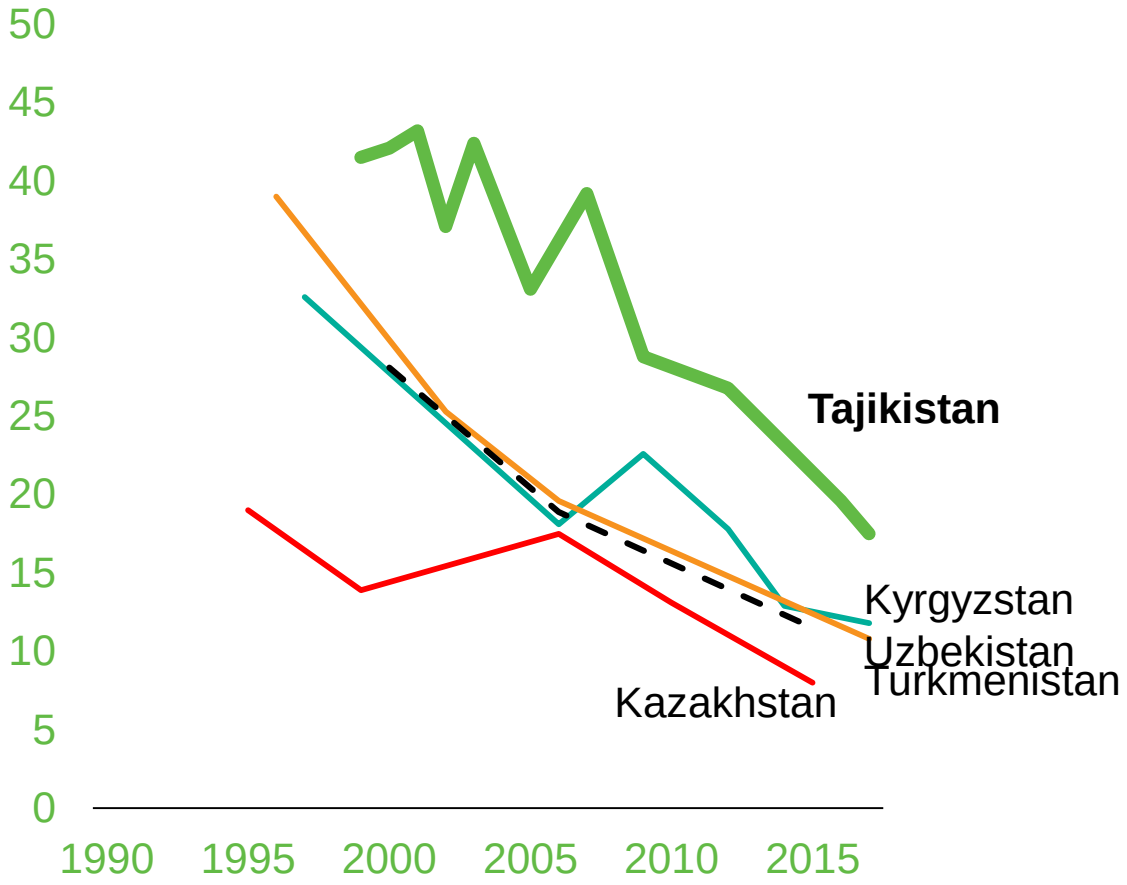
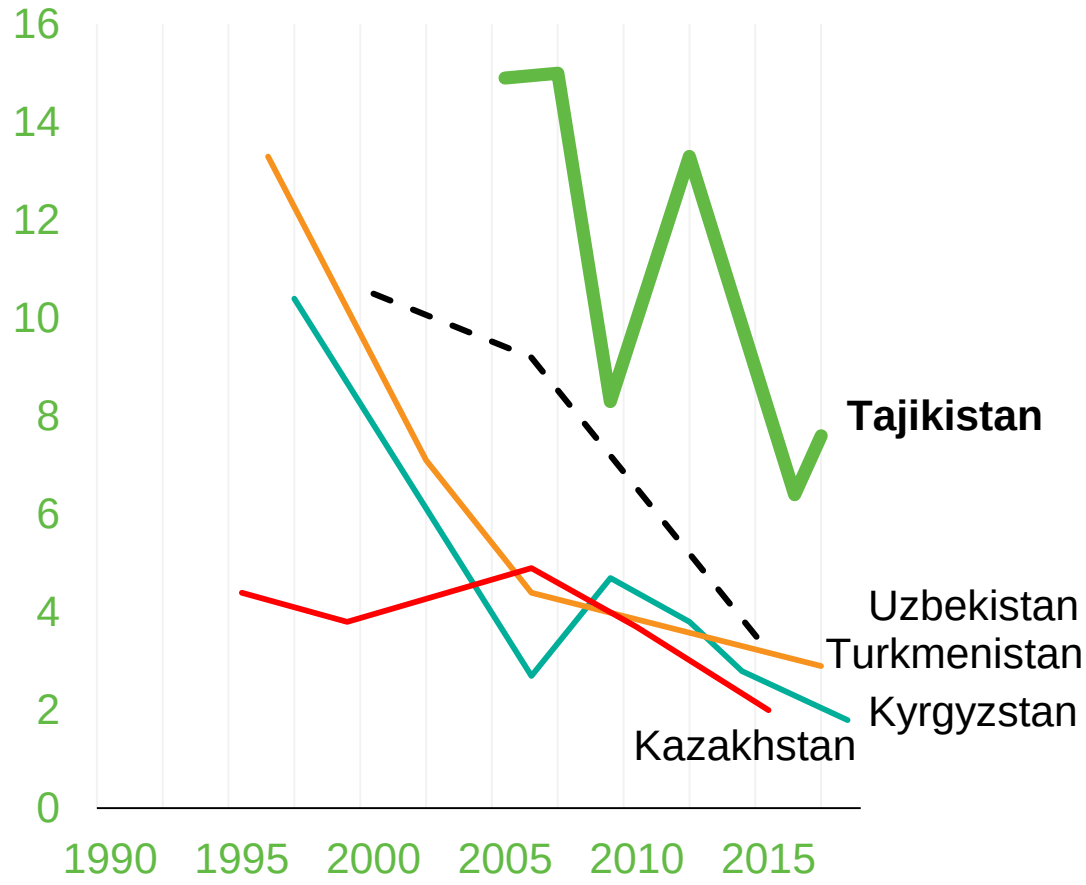
Stunting, underweight have declined but remain higher than other Central Asian countries

Stunting (%) among children under 5

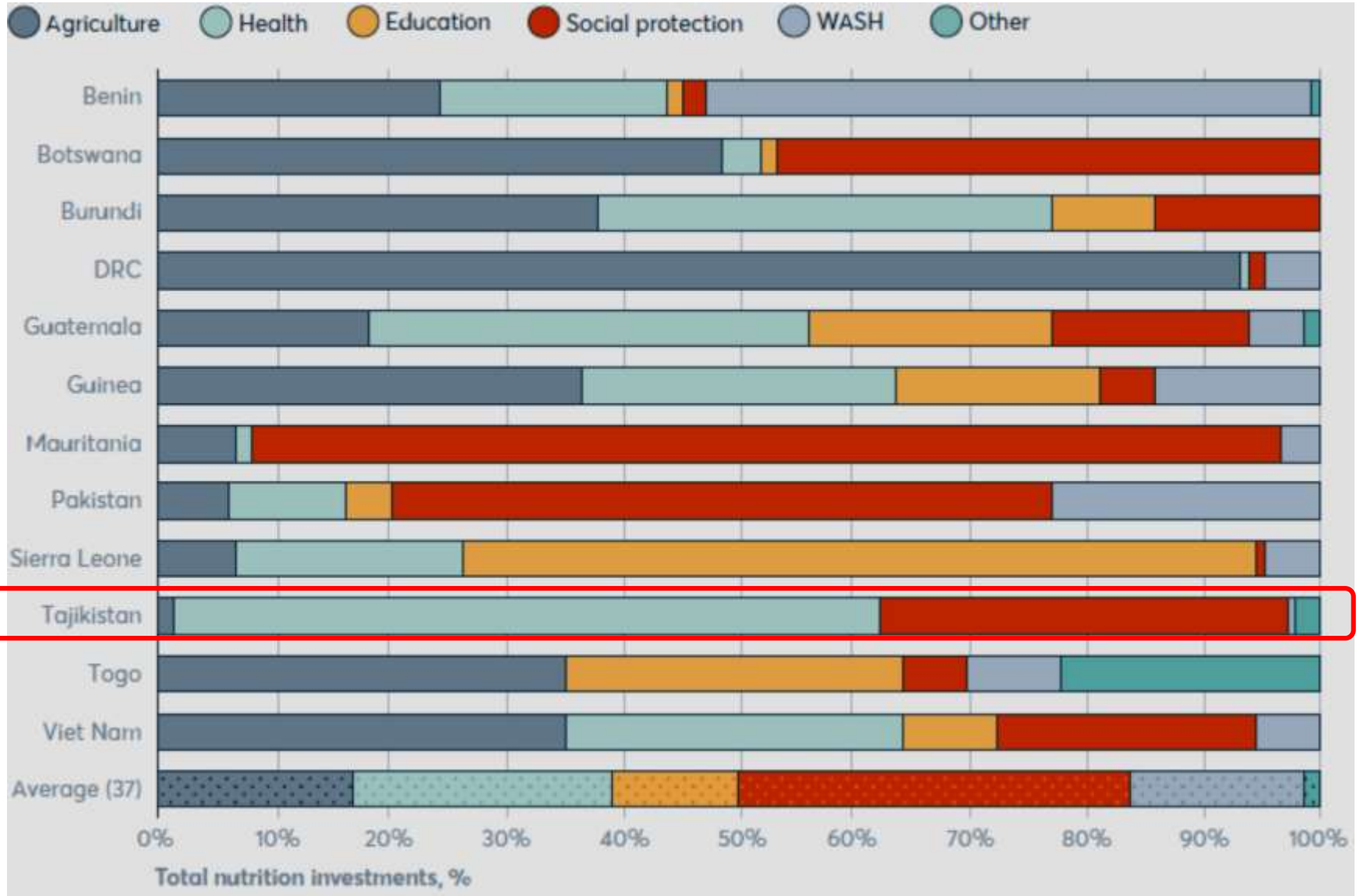


Underweight (%) among children under 5



Source: World Development Indicators

Agriculture is under-utilized for nutrition investments in Tajikistan



Nutrition investments by sector as a percentage of total nutrition investments

Role of agriculture under-appreciated in nutrition strategy in Tajikistan

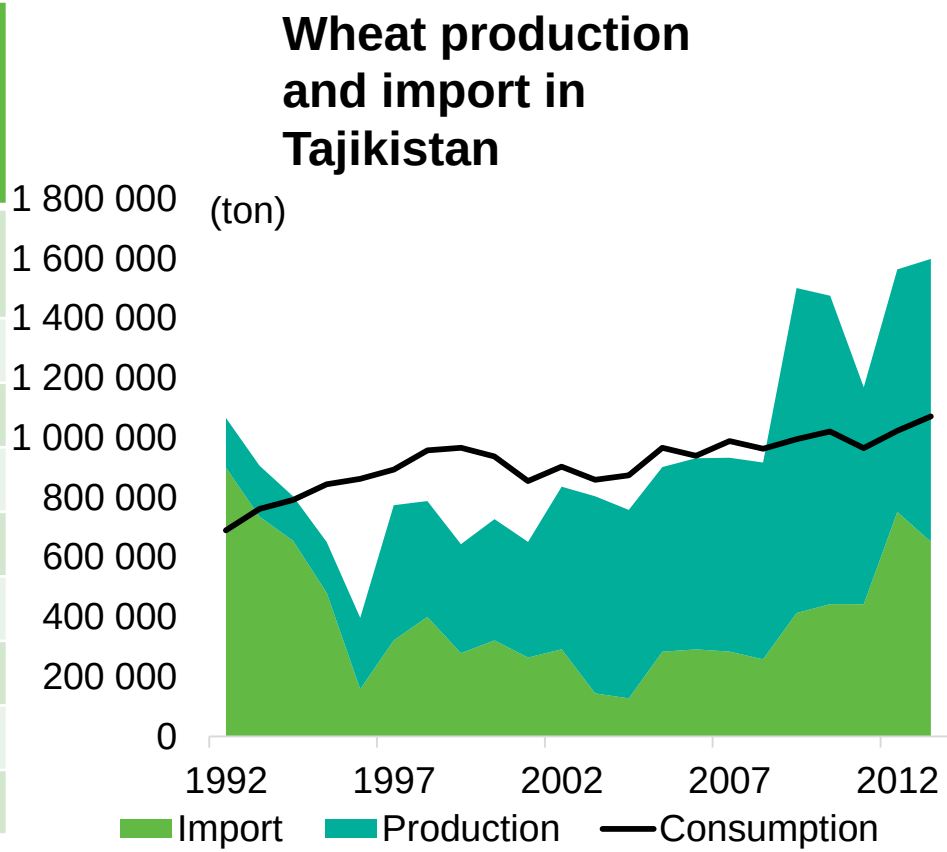
=> More evidence on ag-nutrition linkage can be informative

Global Nutrition Report 2018 (Figure 5.2)

Domestic agriculture has remained important source of nutrition in Tajikistan

	kcal	Protein (g / capita / day)	Fat (g / capita / day)	Share (%) of production	Share (%) of import
Wheat and products	1045	29.3	11.6	48	49
Maize	70	1.6	0.2	100	0
Potato	66	1.6	0.1	96	4
Vegetables, fruits	157	5.0	1.2	100	< 1
Pulses / legumes	21	1.3	0.1	93	7
Milk	97	5.3	5.3	99	1
Meat	160	14.5	10.6	91	9
Total	2201	63.4	60.4		

Source: FAOSTAT 2013.



Source: FAOSTAT.

- Domestic agricultural production as significant source, including wheat

Analytical framework and empirical questions

1.1:
Does household food production affect nutrition ?

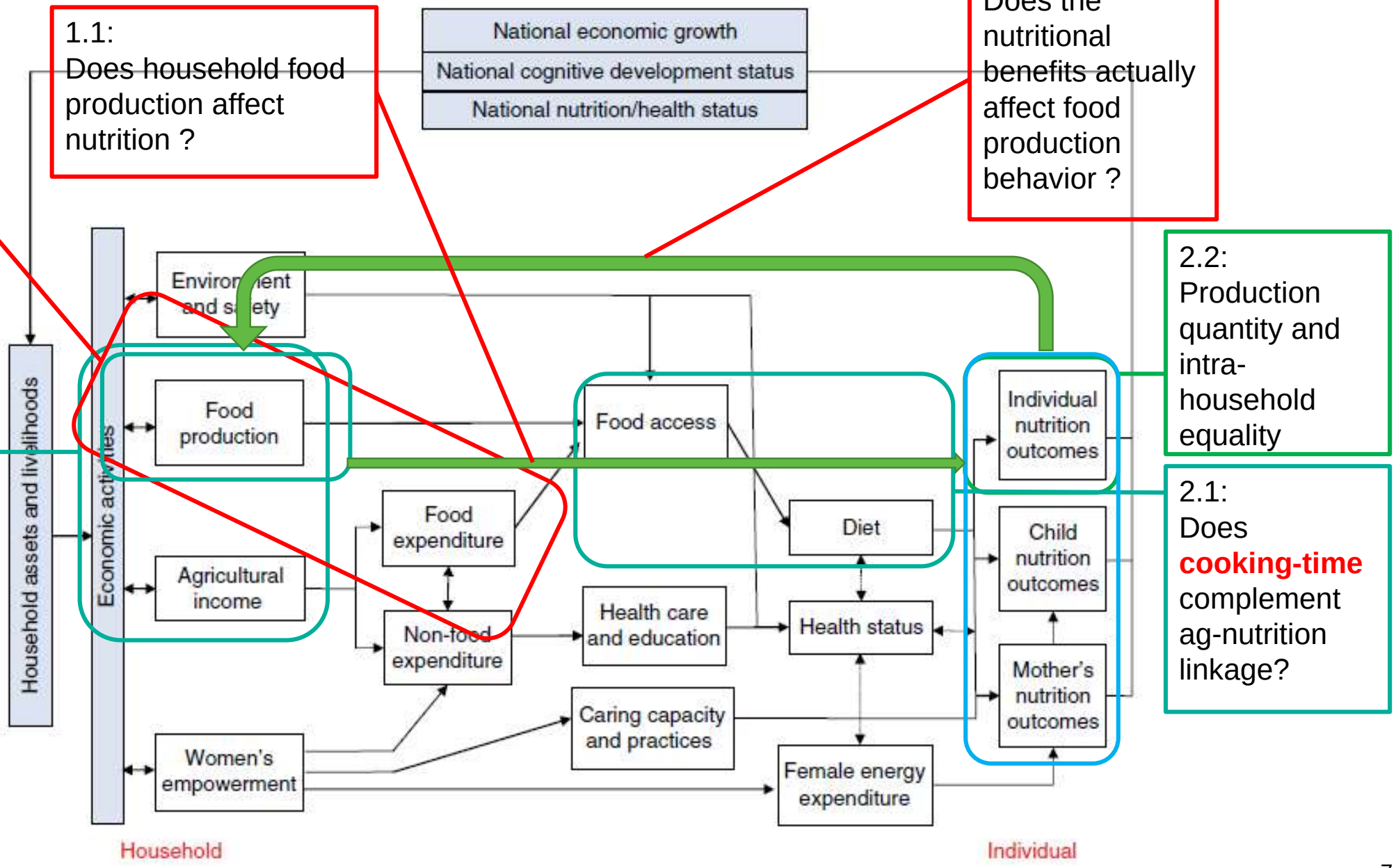
1.2:
Market access and relative role of household food production

1.3:
Does the nutritional benefits actually affect food production behavior ?

2.2:
Production quantity and intra-household equality

2.3:
Does higher technical efficiency matter?

2.1:
Does **cooking-time** complement ag-nutrition linkage?



Source: Modified from Fan et al. (2019).

Paper 1:

Agriculture–nutrition linkages with heterogeneous, unobserved returns and costs: Insights from Tajikistan. *Agricultural Economics 51*(4), 553–565. (Takeshima H, K Akramov, A Park, J Ilyasov, Y Liu & T Ergasheva, 2020).

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If ANL is present due to such nonseparability and the semisubsistence nature of the farm households, the nutritional returns to and costs of particular agricultural production practices (APPs) may become less observable. These returns and costs depend more on nonmarket features; marginal utility derived from agricultural production, and the shadow prices of inputs, rather than observable prices for agricultural outputs and inputs in the markets. If these returns and costs vary across households, the nutritional returns to and costs of APPs also become heterogeneous across households. Furthermore, these unobserved returns and costs can be associated in

Paper 1:
Two datasets are used in the analysis

- 2015 USAID Feed-the-Future (FTF) Mid-line survey (**FTFS 2015**)
  - Collected by IFPRI and Zerkalo
  - Assess the progress on food security related indicators in FTF zone of influence
  - Sample size
    - 2,000 households
    - 12 Raions (districts) in Khatlon region (FTF Zone of Influence)
  - February – March 2015

- 2007 Tajikistan Living Standard Survey (**TLSS 2007**)
  - Multi-stage random sampling
  - Sample size
    - 4,860 (whole Tajikistan)
    - 720 – areas covered under 2015 FTF Mid-line survey
  - September - November 2007

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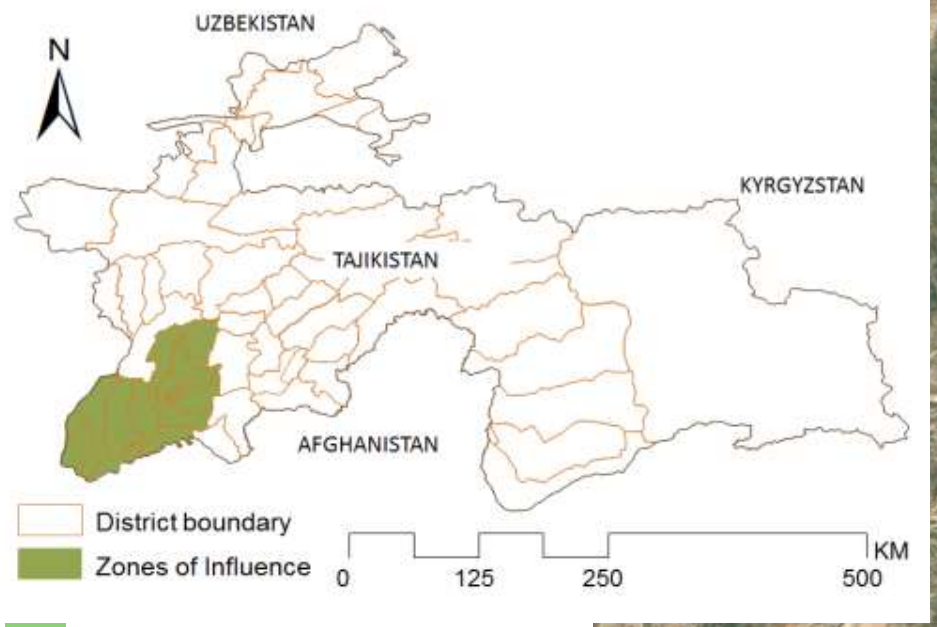
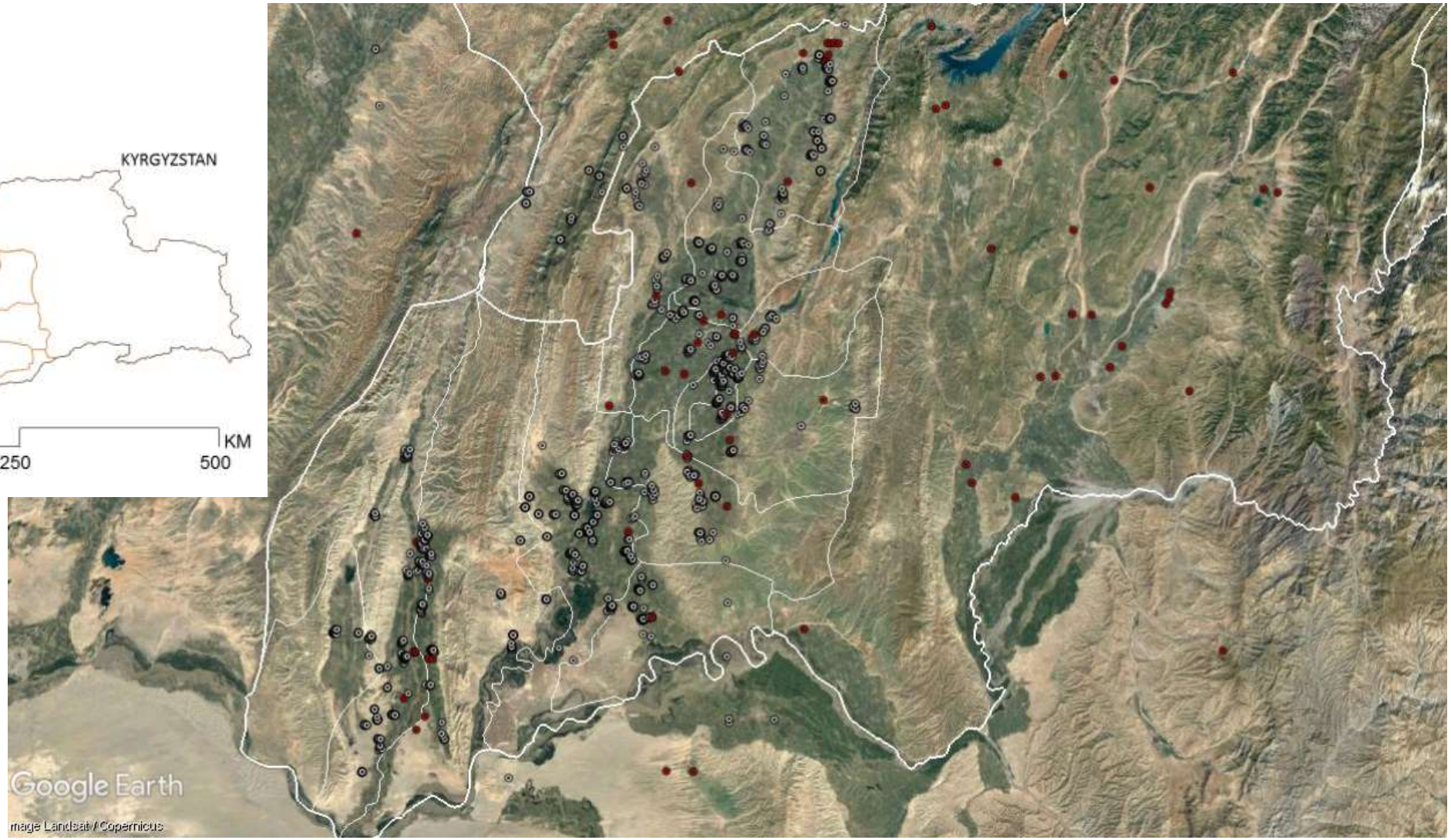
Locations of sample households within Khatlon Province (TLSS 2007, FTFS 2015)





- TLSS 2007
- FTFS 2015

Empirical approaches

A. Associations between *agricultural production practices* and nutritional indicators

1. Agricultural production practices

- Diversification
- Yield
- Production scale

2. Methodologies

a) Propensity score matching

- Binary indicator of various agricultural production practices (below or above sample median)

b) Instrumental variable regression, instrumenting agricultural production practices by

- Extension visit
- Agricultural capital

B. Factors associated with unobserved benefits and costs

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B. Factors associated with unobserved benefits and costs

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

$$\mathrm{U}\left(Y_i^0 + \alpha_i - \phi_i\right) > \mathrm{U}(Y_i^0)$$

α_i: benefits

ϕ_i: costs

$$Y_i = X_i\beta + Z_i\delta + \varepsilon_i + u_i \quad \text{if } T_i = 1$$
$$Y_i = X_i\beta + \varepsilon_i \quad \text{if } T_i = 0$$

$T_i = 1$ if $T_i^* > 0$;

$T_i = 0$ otherwise

$$T_i^* = Z_i\delta - W_i\eta + u_i - v_i$$

$$\alpha_i = Z_i\delta + u_i \quad (\alpha_i \text{ is unobserved})$$
$$\phi_i = W_i\eta + v_i \quad (\phi_i \text{ is unobserved})$$

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	Data
Dietary diversity	Household	12 food groups (7-day recall)	FTFS 2015, TLSS 2007
	Children	6 or 7 food groups (1-day recall)	FTFS 2015
	Women	9 food groups (1-day recall)	FTFS 2015
Anthropometrics	Children	Height, weight	FTFS 2015, TLSS 2007
	Women	Height, weight	FTFS 2015

Agricultural production characteristics (household level)

Categories	Measurements (household level)	Data
Diversification	Number of food groups produced	FTFS 2015, TLSS 2007
Yield	Total production value per cultivated area	FTFS 2015, TLSS 2007
Production scale	Total production value per capita	FTFS 2015, TLSS 2007

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Explanatory variables

Categories	Variables
Household demographics	• Age / gender of household head • Number of male and female household members of various age groups (0 ~ 5 years old, 6 ~ 15, 16 ~ 60, and 61 or above) • Members living away from home for at least 6 months
Human capital	• Years of education among working age household members (gendered)
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	• Per-capita value of durable assets • Ownership of key livestock animals • Types of 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 • 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 (Children's and women's outcomes)

Children

Categories	Variables
Demographics of children	Age, gender of the children
Pre-natal environmental shocks	12 months rainfall anomaly before the births
Seasonality of birth	Birth quarter
Primary caregiver	Age of primary caregiver
	Education level of primary caregiver

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)

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) • Output price of crops produced
Factors potentially affecting the costs but not benefits	• Extension visit • Agricultural capital

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Results: Dietary diversity – household and children

Outcomes	Ag production practices	Instrumental variable regression			Propensity score matching		
		All	Poor access	Good access	All	Poor access	Good access
HDDS (*count*)	Diversification (*count*)	.652***	.462**	.159***	.118***	.133***	.131***
	Yield (*natural log*)	.112***	.107***	.672**	.184***	.137	.069
	Scale (*natural log*)	1.263**	1.234	.102	.128***	.179**	.003
Children achieving minimum acceptable diet (*yes = 1*)	Diversification	.006	.014	-.123	-.002	.005	.012
	Yield	.010	.013	-.066	-.010	.117**	-.074
	Scale	.002	.005	.004	.013	.028	.040*
Children achieving minimum acceptable dietary diversity (*yes = 1*)	Diversification	.022**	.037***	-.001	.008	.046**	.007
	Yield	.022**	.019	.023*	.021	.137**	.000
	Scale	.010	.011	.001	.022	.058*	.053*

- **Stronger effects of agricultural production practices where market access is poor**
- **Sometimes even negative in areas with good access, possibly due to higher opportunity costs**

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Results: Women of reproductive age

Outcomes	Ag production practices	Instrumental variable regression			Propensity score matching		
		All	Poor access	Good access	All	Poor access	Good access
Women's dietary diversity score (*count*)	Diversification (*count*)	.241***	.302***	.171***	.199***	.288***	.130**
	Yield (*natural log*)	.157***	.114***	.155***	.423***	.463***	.250*
	Scale (*natural log*)	.076***	.063*	.038	.103*	.210**	-.054
Women achieving dietary diversity >= 5 (*yes = 1*)	Diversification	.044***	.063***	.020**	.046***	.067***	.019
	Yield	.035***	.030***	.035***	.076***	.099***	.032
	Scale	.006	.012	-.008	.007	.030	-.015
Body mass index is normal (*yes = 1*)	Diversification	.004	-.006	.019**	.018*	-.003	.025
	Yield	-.013*	-.003	-.023**	-.035	-.004	-.068
	Scale	-.008	-.001	-.012	-.003	-.002	.004

- **Stronger effects of agricultural production practices where market access is poor**
- **Sometimes even negative in areas with good access, possibly due to higher opportunity costs**

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Results: Children's anthropometrics

Outcomes	Ag production practices	Instrumental variable regression			Propensity score matching		
		All	Poor access	Good access	All	Poor access	Good access
Height-for-age (*Z-score*)	Diversification (*count*)	.072**	.108***	.002	.013	.125**	-.050
	Yield (*natural log*)	.006	.073	-.056	-.023	.218	-.294
	Scale (*natural log*)	.059	.161**	-.095	.114	.227*	-.055
Not stunted (*no stunting = 1*)	Diversification	.019***	.029***	-.006	.015	.008	-.009
	Yield	.115	-.007	.018	-.048	.064	-.071
	Scale	.021**	.068***	-.015	.041*	.100***	-.006
Weight-for-age (*Z-score*)	Diversification	.000	.041	-.038	.071*	-.044	.043
	Yield	-.344	.053	.001	.127	-.044	-.030
	Scale	.035	.087**	-.041	.053	.186*	.070

- **Stronger effects of agricultural production practices where market access is poor**
- **Sometimes even negative in areas with good access, possibly due to higher opportunity costs**

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Results: Effects on incomes

Outcomes	Ag production practices	Instrumental variable regression			Propensity score matching		
		All	Poor access	Good access	All	Poor access	Good access
Household incomes per capita (*Natural log*)	Diversification (*count*)	.210*	.018	.031*	-.006	.003	-.003
	Yield (*natural log*)	.023*	.012	.391**	.040	.028	.006
	Scale (*natural log*)	.421*	.043**	.029	.015	.089**	-.044

- **Where market access is poor, household food production has less effects on income (esp. diversification, yield enhancement)**
- **Where market access is poor, agriculture-nutrition linkage is more through subsistence consumption**
- **Where market access is good, more effects on income and food purchase, but small magnitudes**

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APPs for particular nutritional outcomes	Yield enhancement for raising children's height-for-age		Crop diversification for improving WDDS	
Factors associated with returns or costs	Returns	Costs	Returns	Costs
Age of household head	-.002	.001	-.004	.001
Gender of household head	-.407	-.106	-.796	.121
Female, > 60 years old	.170	-.008	-.103	.056
Female, 16–60 years old	-.061	-.020	.021	.010
Female, 6–15 years old	-.129	-.022	-.092	-.037
Female, < 6 years old	.010	-.006	.039	.043
Male, > 60 years old	.390	-.191*	.307	-.111
Male, 16–60 years old	.302**	-.046	.001	-.009
Male, 6–15 years old	-.225*	.045	.174*	-.055**
Male, < 6 years old	-.137	-.037	-.051	-.012
Education	.099	-.020	.177**	-.009
Durable asset (ln)	-.002	-.005	.040	-.038***
Improved sanitation	-2.079	.585*	.864	.049
Finished floor	-.196	-.068	-.223	-.149**
Finished wall	-.077	-.185*	-.153	-.003
Improved water source	-.200	-.021	.130	.238***
Garbage collection	-.209	.491*	-.863	.225
Sewage system	-1.563	.955*	-1.504***	-.114
Own cow	.435	-.190*	.953**	-.323**
Distance to food market	.078	-.014	.141**	-.016
Altitude	.000	-.000	-.003	-.000
Rainfall	.003	-.003*	.004	.001
Distance to river	.032	-.011*	.000	-.003
Groundwater depth	-.001	-.003	-.009	.006***
Ruggedness	-.007	.002*	-.001	-.000
Obtained credit	.440	-.236	-.150	.066
Area share of perennial crops (ln)	.132	-.263**	.693	-.130
Remittances received (ln)	-.023	-.006	.026	-.032***
Owned farm area (ln)	-.570	.461***	1.096**	-.083
Received inoculation campaign	.038		-.349	
Birth order	.052			
Prebirth rainfall	.002			
Born in April–June	.354			
Born in July–September	.493			
Born in October–December	.410			
Age of caregivers	1.279**			
Education of caregivers	.031			
Gender of the child	-.058			
Age of the child	.000			
Chronic illness	-2.097			
Diarrhea	1.432			
Ambulance	-6.792*			
Frequency of ambulance	-2.967			
Health condition	.520			
At least one child with respiratory disease	1.465			
At least one child with Diarrhea	-1.553			
At least one child with ambulance	-.002			
Women's age			-.003	
Women's education			-.017	
Pregnant			.148	
in_union			-.049	
Widowed			1.598**	
Divorced			.274	
Separated			-.957	
Food price	-.366		1.219**	
Own refrigerator, freezer	.131		.109	
Inverse Mills ratio	-2.656		-3.325***	
Receiving extension visit		-.083		-.169***
Agricultural capital (ln)		-.030**		-.024**
Year dummy	Included	Included	Included	Included
Intercept	Included	Included	Included	Included
Effects of expected benefit on the adoption	.192*		.213*	
No. of obs.	1847	1847	2689	2689

Decompositions of unobserved benefits and costs by Lee (1979) - Maddala (1983) - Björklund & Moffitt (1987) method

Results: Decompositions of unobserved benefits and costs

Outcome	Children's height-for-age		Women's dietary diversity	
Agricultural production practice	Yield enhancement		Crop diversification	
	Benefits	Costs	Benefits	Costs
Education	.099	-.020	.177**	-.009
Distance to food market	.078	-.014	.141**	-.016
Food price	-.366		1.219**	
Receiving extension visit		-.083		-.169***
Agricultural capital		-.030**		-.024**
Effects of nutrition benefits on the adoption of agricultural production characteristics	.192*		.213*	
No of obs.	1,847	1,847	2,689	2,689

Education of household members raises the benefits of crop diversification on women's dietary diversity

In more remote area - higher benefits of crop diversification on women's dietary diversity

Higher food price - higher benefits of crop diversification on women's dietary diversity

Extension, agricultural capital – reduces the costs of yield enhancement, crop diversification

Expected benefits induce particular agricultural production practices

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Paper 1: Key messages

- In Tajikistan's Khatlon province, agriculture has important linkages with household nutrition
  - Poor-access areas:
    - Household's nutrition is affected by agricultural production through **direct consumption** of farm products, rather than through incomes earned from farm products
  - Good-access areas
    - Household's nutrition is affected by agricultural production through **incomes** earned from farm products, rather than direct consumption of farm products
- Households recognize the net benefits on nutritional outcomes, and adjust their farm production accordingly given the costs.
- However, net benefits also vary across households. Agricultural production practices of diversification, intensification, expansion may be costly among resource-poor farms, despite the benefits
  - Improving access to extension, agricultural equipment - important for nutrition-sensitive agriculture among smallholders in rural areas in Tajikistan
- As market access improves over time, nutritional outcomes depend increasingly on incomes from non-farm sector. Agriculture-nutrition linkage at the household level weakens.
- However, improving market access takes time. It requires;
  - Investments in road infrastructure; road length has not changed much since 1991
  - More migration to good-access areas
  - Evolution of secondary, tertiary towns in rural areas
- Therefore, in the short-to-medium term, need to directly support agricultural production by households in remote, poor-access areas

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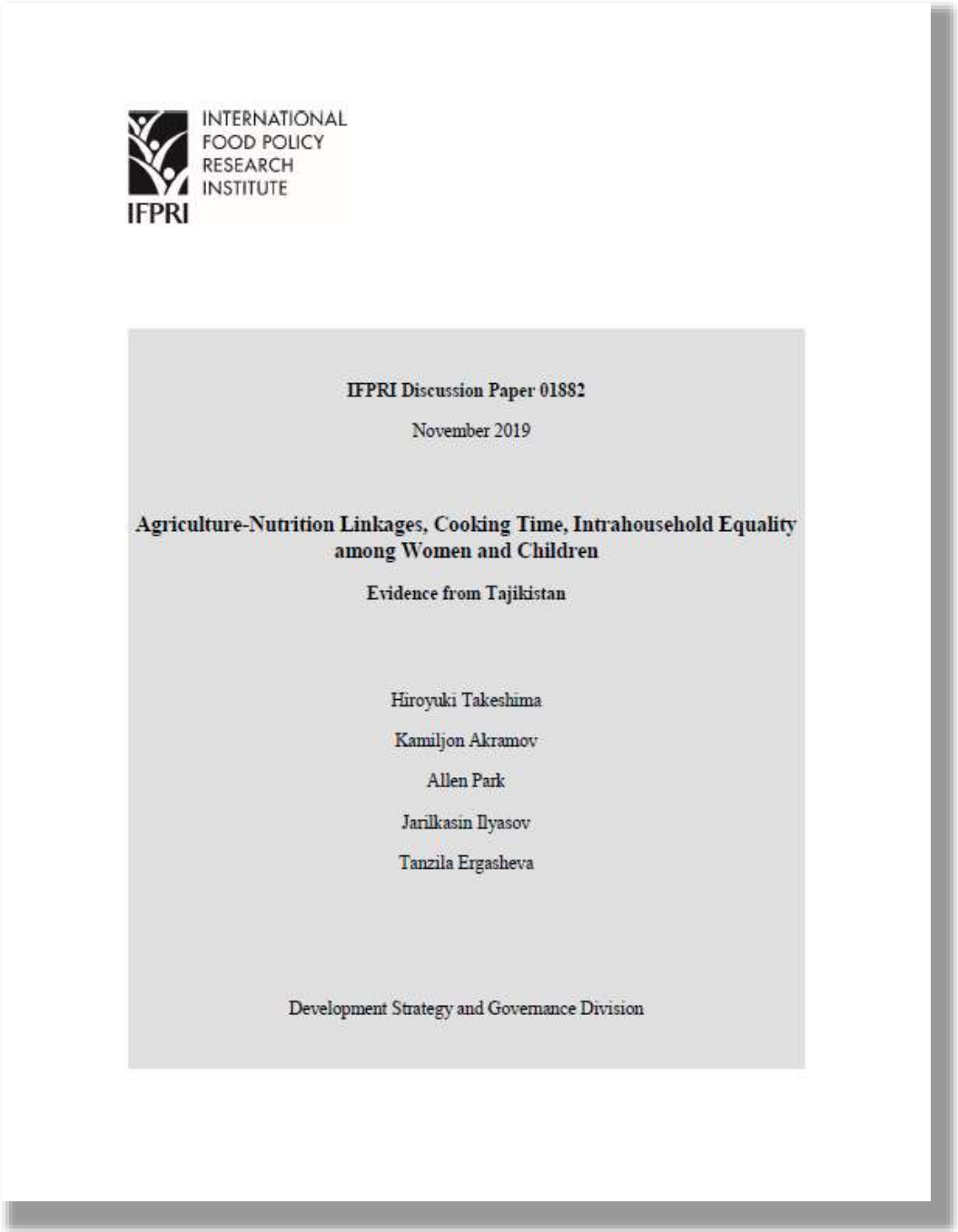
Paper 2:

Agriculture-nutrition linkages, cooking-time, intra-household equality among women and children: Evidence from Tajikistan. IFPRI Discussion Paper 01882. (Takeshima H, K Akramov, A Park, J Ilyasov & T Ergasheva, 2019)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Paper 2: Literature

Agriculture-nutrition linkage in Tajikistan

- **Strong linkage at household-level, especially in more subsistence regions** (Takeshima et al. 2020)
  - Dietary diversity (household, children, women), stunting

Time allocations for cooking / child care

- **Importance of time allocations for cooking / child care** (Komatsu et al. 2018; Johnston et al. 2019)
  - E.g., bioavailability of nutrients in cooked food
- **Household food production and time allocations for cooking / child care – are they complementary? – little evidence**

Intra-household variations (among women)

- **Variation in dietary requirements** – pregnancy, lactation, economic activities, etc. (Pitt et a. 1990; Harris-Fry et al. 2017)
- **Age** (Oddo et al. 2012; Lhotska et al. 2015; Hasan et al. 2017; Beal et al. 2017; Kerr 2017; Nguyen et al. 2018; Khanam et al. 2018; Dillon et al. 2018)
- **Marriage status** (Keding et al. 2011)
- **Household wealth / income, household size** (Haddad et al. 1997)
- **Household-level food availability** (Harris-Fry et al. 2017)
- **Does aggregate quantity matter for intra-household allocations of nutrition?** – little evidence

Productivity, technical efficiency

- **Efficiency** of nutrition-sensitive agriculture (NSA)
  - Cost of NSA – little evidence (Ruel et al. 2018)
- **High resource-requirements of many NSA interventions**
  - Labor - increased burden on female members (Johnston et al. 2019)
- **Does raising ag productivity / efficiency improve nutrition?** - little evidence

=> Need more evidence for these aspects within the agriculture-nutrition linkage

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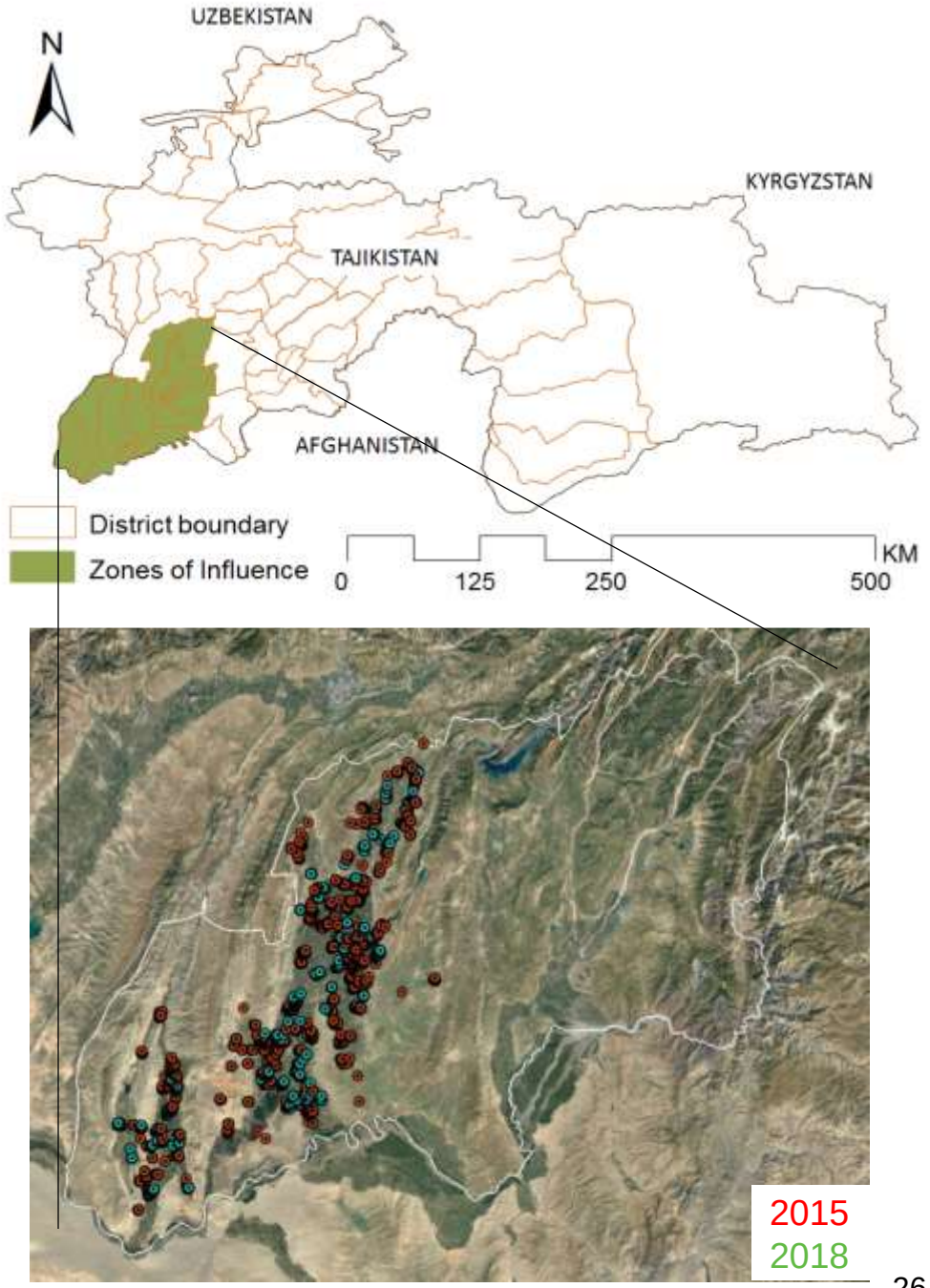
Data

Tajikistan's Khatlon province

- 2015 February – March
  - 2000 households
  - About 3500 women of RPA
  - Representative within Zones-of-Influence (USAID Feed-the-Future)
- 2018 August
  - 1200 households
  - About 2000 women of RPA
  - Purposively selected (growing targeted crops)
  - More commercial



Source: Google Earth; IFPRI Surveys 2015/2018

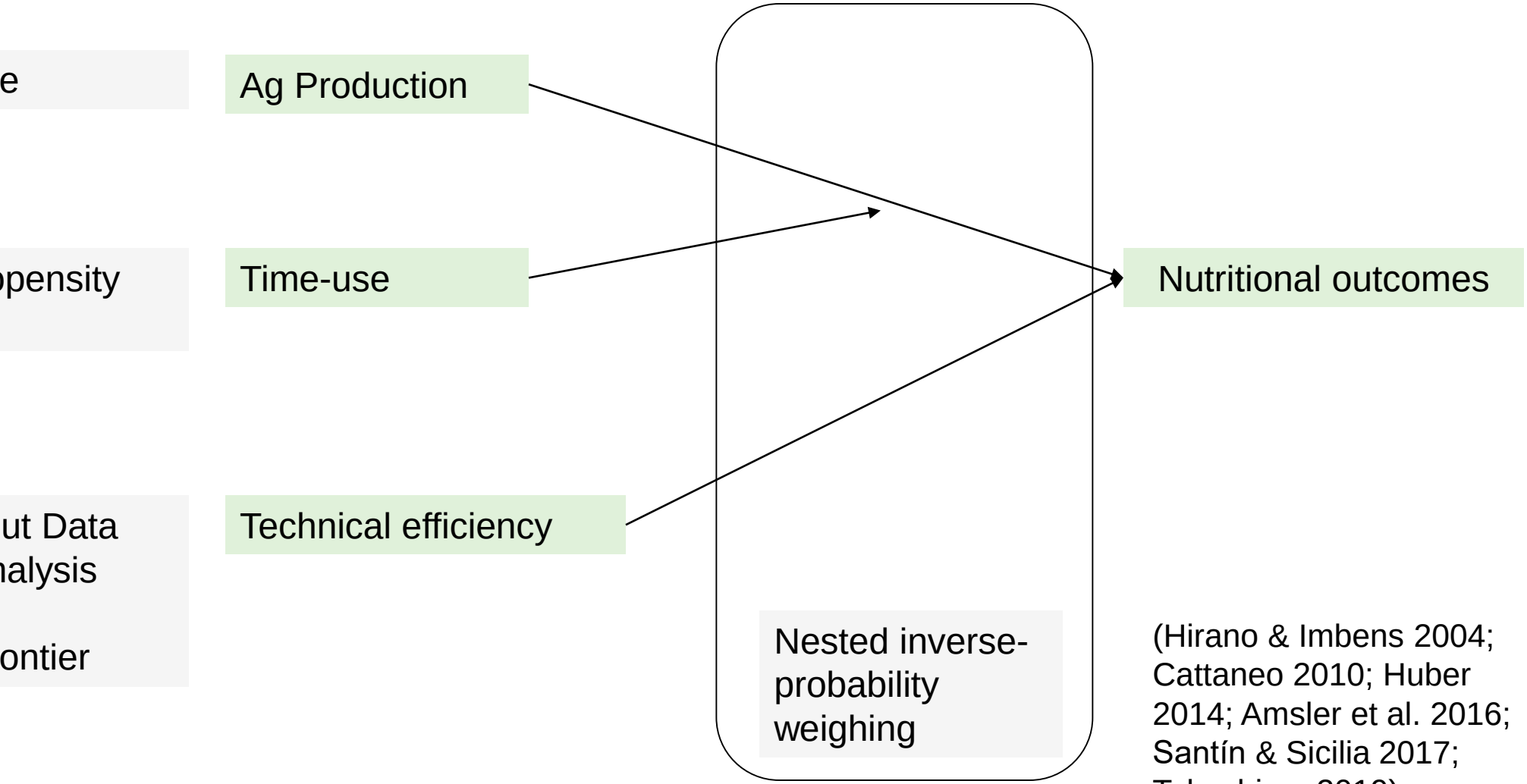
Empirical methods: Multi-level propensity-score based estimations, Data Envelopment Analysis

Propensity Score

Generalized Propensity Score Method

Instrumental input Data Envelopment Analysis

IV-Stochastic Frontier

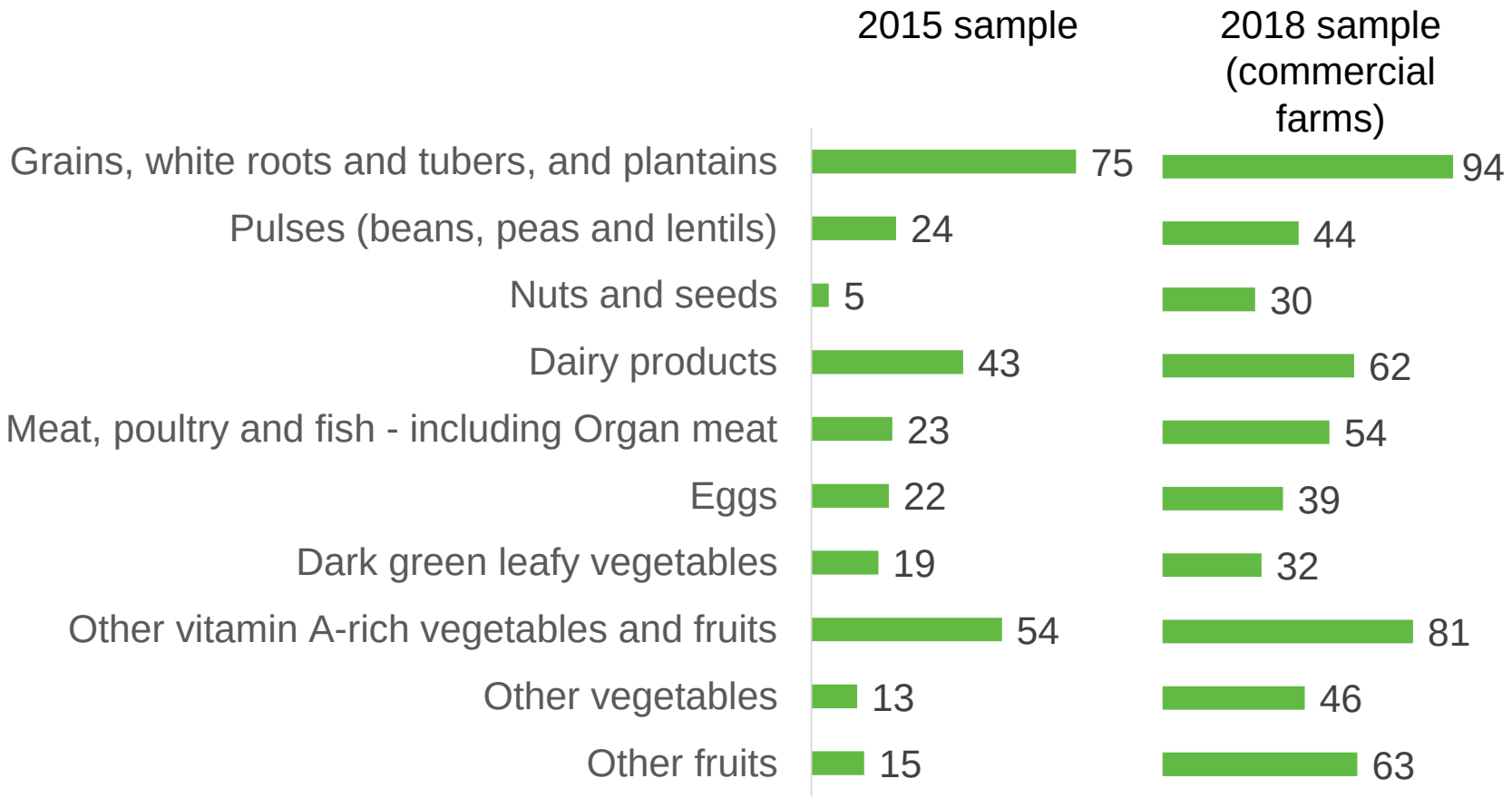


(Hirano & Imbens 2004; Cattaneo 2010; Huber 2014; Amsler et al. 2016; Santín & Sicilia 2017; Takeshima 2019)

Nutritional outcome indicators: Dietary diversity of women

- Women of reproductive age (15-49) – 24 hour recall
- 10 food groups
- In hhds with multiple respondents,
  - WDDS differ among women in 45% of hhds
  - intra-household variations = 20-30% of all variations

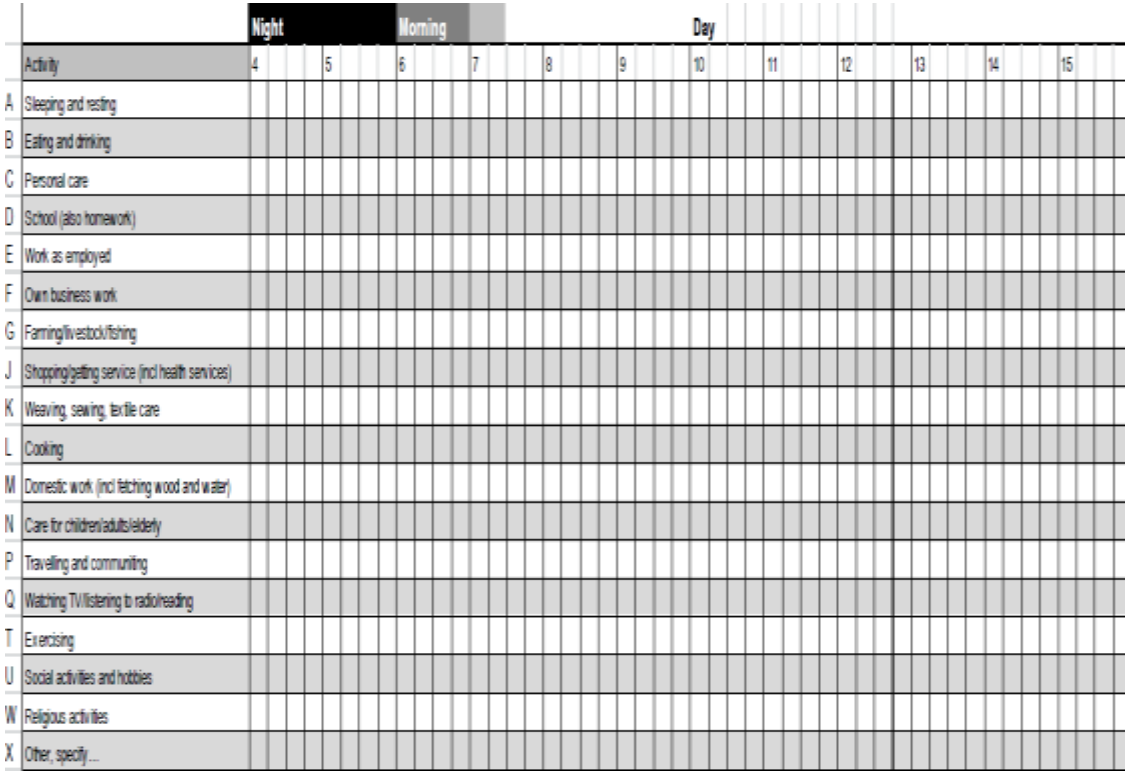
% of women consuming each food group



Women Dietary Diversity Score	2015 sample	2018 sample
Mean	2.96	5.43
Std.dev	2.39	2.40

Source: IFPRI Surveys 2015/2018

Data: Time-use
24-hour recall, primary respondent of the household



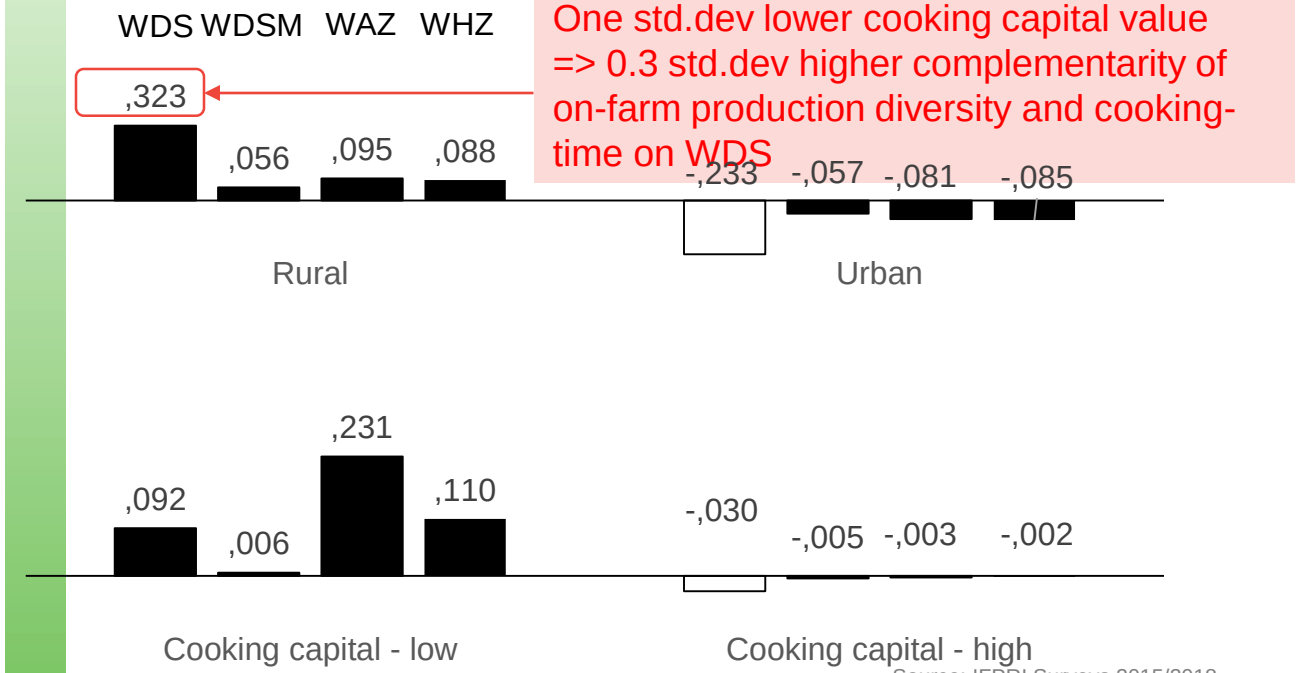
Primary respondent:

- One per household
- Mostly female of reproductive age (15-49 yrs old)

Source: IFPRI Surveys 2015/2018

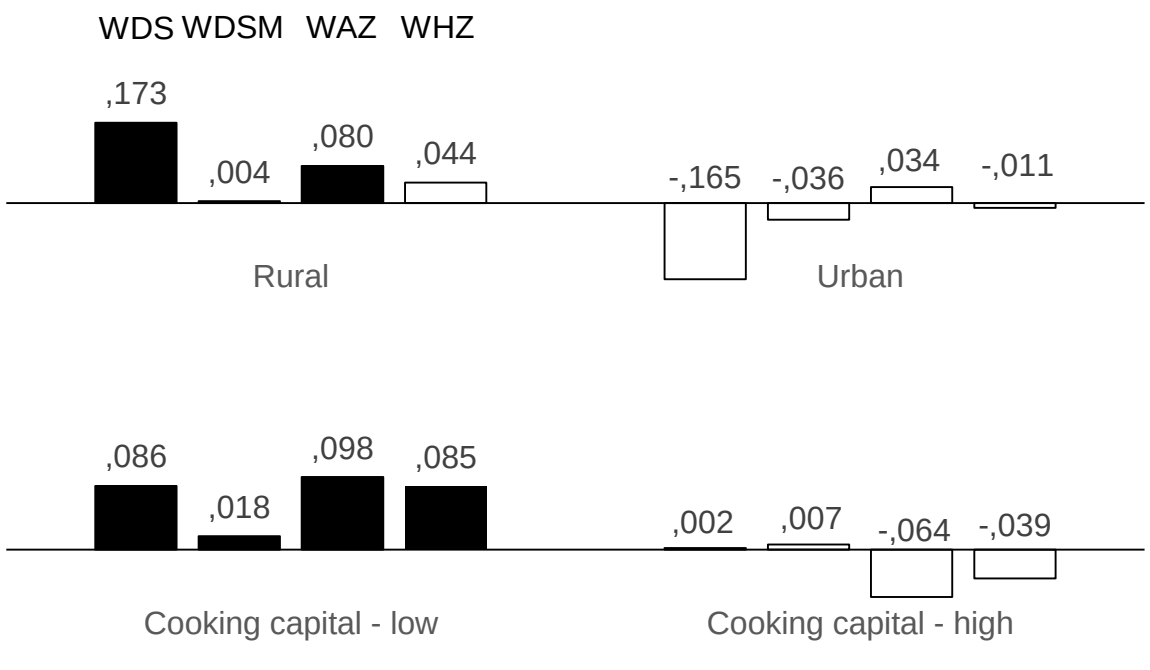
Results 1: Household food production is more complementary to cooking-time for the nutrition of rural households with lower cooking-capital

Complementarity between cooking time and on-farm production diversity



One std.dev lower cooking capital value => 0.3 std.dev higher complementarity of on-farm production diversity and cooking-time on WDS

Complementarity between cooking time and agricultural production value



Source: IFPRI Surveys 2015/2018

(Results are similar in IVGMM methods)

For rural, poor households with simple (less modern) cooking equipment, household food production and investing in cooking-time are important tools for nutritional improvement of women and children

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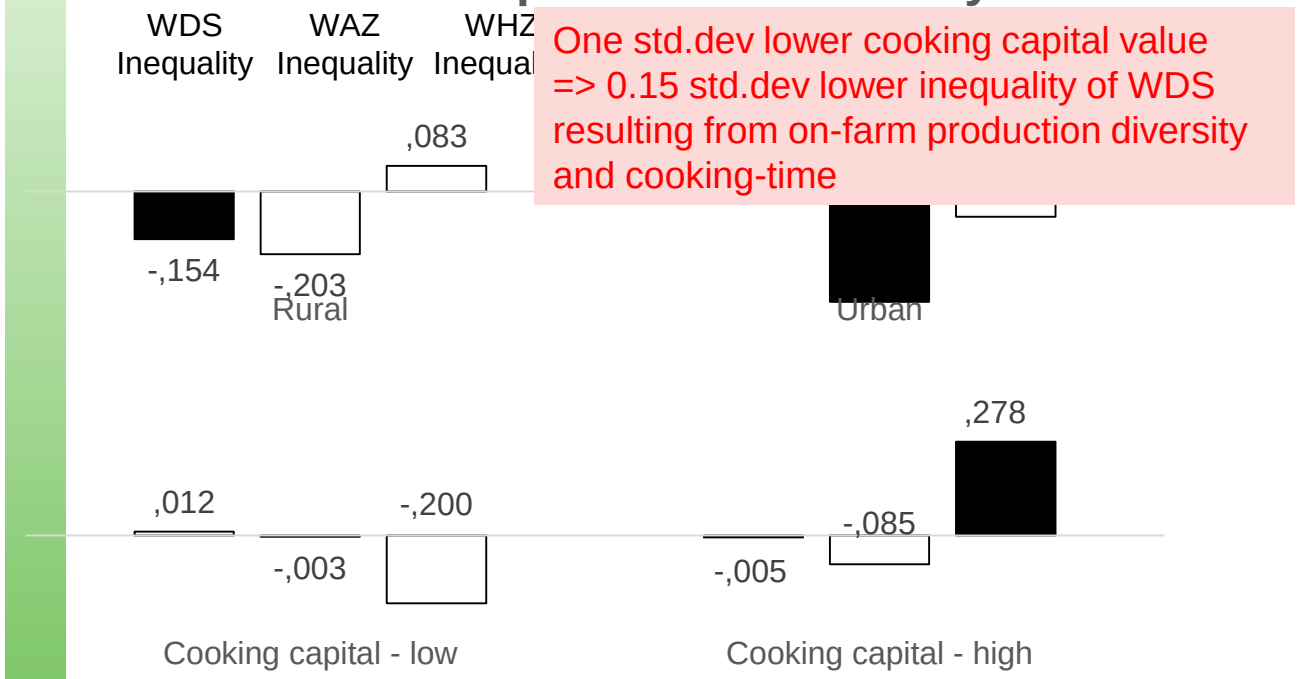
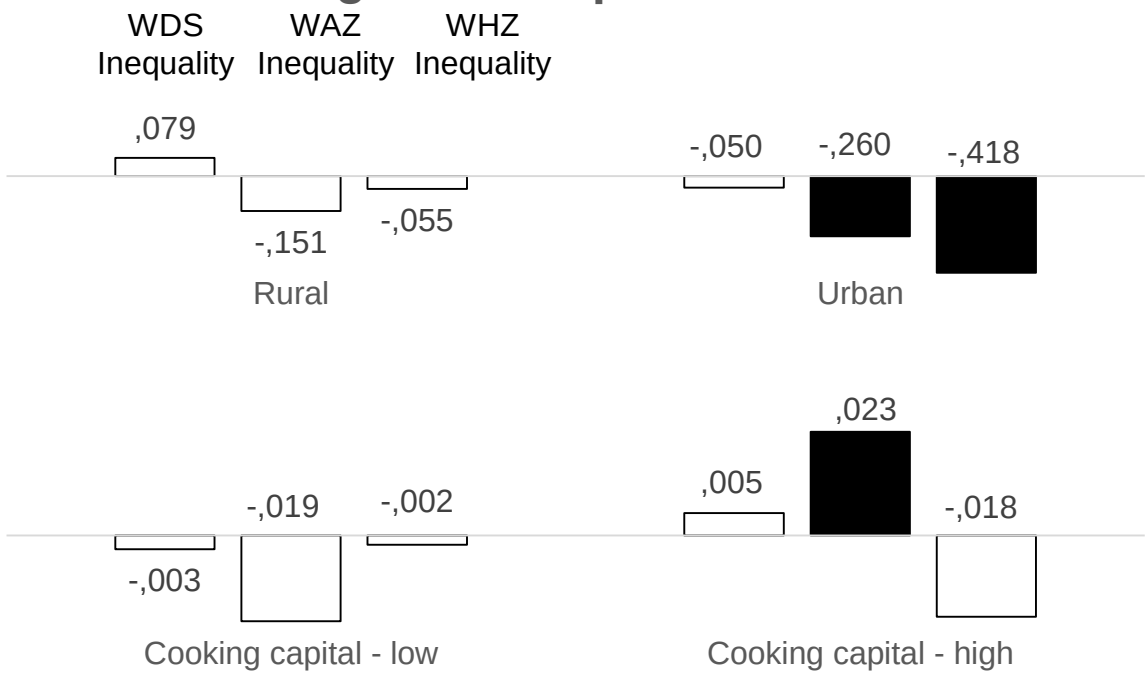
Results 2: Household food production and cooking-time do not aggravate intra-household nutrition inequality among women and children in rural households with lower cooking-capital

Complementarity between cooking time and on-farm production diversity



One std.dev lower cooking capital value => 0.15 std.dev lower inequality of WDS resulting from on-farm production diversity and cooking-time

Complementarity between cooking time and agricultural production value



Source: IFPRI Surveys 2015/2018

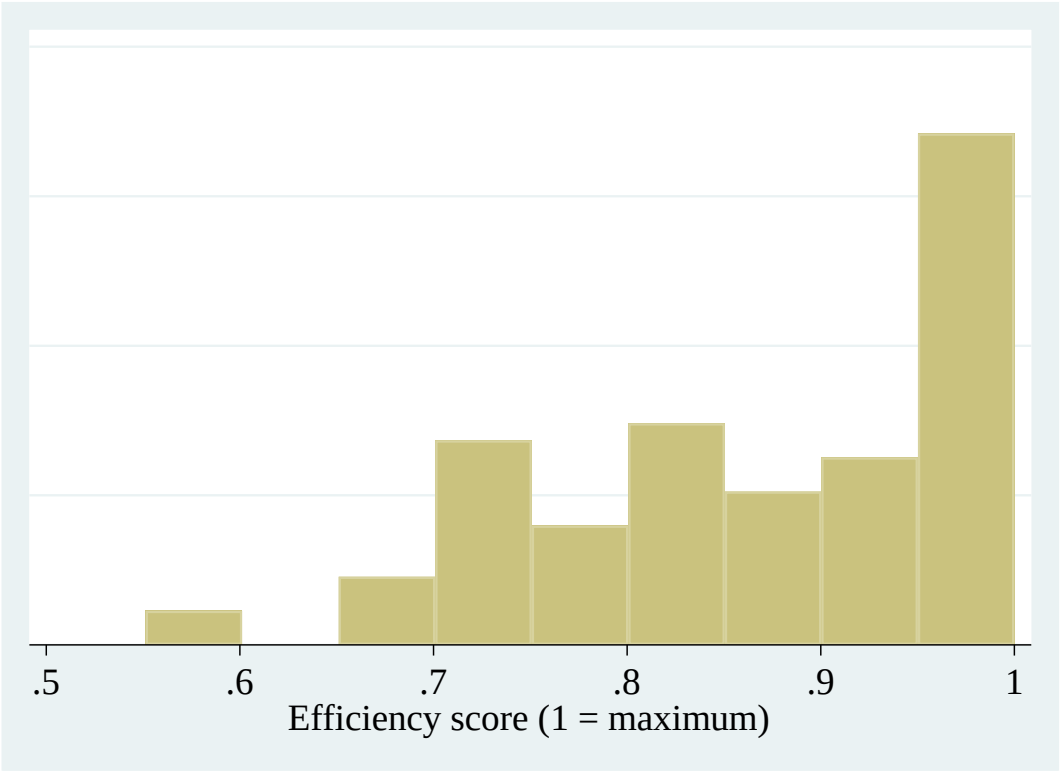
(Results are similar in IVGMM methods)

For rural, poor households with simple (less modern) cooking equipment, household food production and investing in cooking-time are important tools for nutritional improvement of women and children

They also generally do <u>not</u> aggravate intra-household inequality among women / children

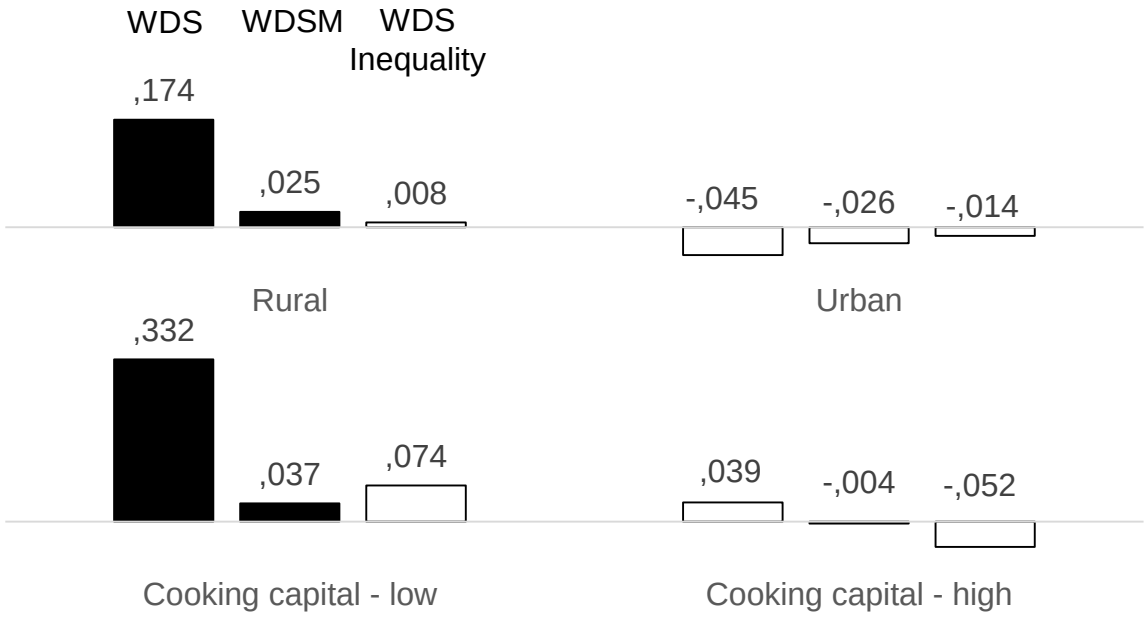
Results 3: Agricultural technical efficiency is more complementary to cooking-time in rural area, and households with lower cooking-capital

Distribution of technical efficiency



Source: Data Envelopment Analysis.

Complementarity between technical efficiency and cooking time



Source: IFPRI Surveys 2015/2018

One std.dev increase in Technical Efficiency
=> Increase DDS of all women by 0.17 per 1 hour of cooking

For rural, poor households with simple (less modern) cooking equipment, household food <u>productivity / efficiency</u> and investing in cooking-time are important tools for nutritional improvement of women and children

Paper 2: Key messages

- Household's own production remains important because
  - Cash incomes are insufficient
  - Food market is inaccessible and risky (which poor households cannot bear)
  - Scale economies have not yet emerged and smallholder production system is still more efficient
- Diversity and quantity of food produced – both important
  - Diversity – raise overall dietary diversity
  - Quantity – reduce intra-household inequality in dietary diversity
- Nutrition-sensitive time-allocation - more effective when raw food items are diverse and abundant
- Raising technical efficiency of farm production further strengthens these linkages

=> Our study provides direct evidence for these hypotheses

In the short- to- medium terms,

- Promotion of nutrition-sensitive time-allocations should combine improved household food production
- Crop diversification (home garden etc.) should also achieve certain scale (quantity of each food group)
- Public investments for technical efficiency improvements
  - Agricultural R&D and extension for diverse commodities (vegetables / fruits, livestock, not only grains)
  - Location-specific agricultural R&D;
  - Farm management skills transfer across generation

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Conclusions

- **Food-based approach** is equally important for nutrition as medical approach, especially where infrastructure for supervision of supplementation and fortification is limited (Howson et al. 1998; Allen & Gillespie, 2001)

- **Nutrition-sensitive approach** equally important as **nutrition-specific approach**

- **Agricultural production at household level**

⇒important **food-based / nutrition-sensitive approach** in itself

⇒important catalyst for other food-based / nutrition-sensitive approach

- **More evidence continues to be needed** in different settings, and can be attained through the empirical methods used in our study

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Thank you !

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