

Agricultural Diversity, Dietary Diversity, and Nutritional Outcomes in Central Asia

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Motivation

- All forms of malnutrition has high human and economic costs
- Stunting, a marker of chronic undernutrition, has many long lasting negative consequences
 - Cognitive impairment
 - Lower work productivity
 - Higher risks of noncommunicable diseases
- No magic bullet for solving malnutrition problem
 - Nutrition-specific interventions
 - Nutrition-sensitive interventions
 - Nutrition-sensitive agriculture has great potential (WB 2007, Ruel and Alderman, 2013)

Motivation (Continued)

- Despite recent improvements, Central Asian countries continue to experience overlapping burdens of malnutrition
- Tajikistan (stunting, underweight & WRA); Kazakhstan, Kyrgyzstan, and Uzbekistan (overweight, underweight & WRA)
- Stunting among children under 5 remains relatively high, varying between 13% in Kazakhstan to 27% in Tajikistan (WHO/UNICEF/World Bank 2015)
- Significant share of calorie intake comes from cereals (wheat)
- Agricultural production systems, especially in Tajikistan and Uzbekistan, are dominated by wheat and cotton

Motivation (continued)

- The current strategies of national governments and development partners include promotion of agricultural diversification
- However, there is little evidence regarding the linkages between agricultural diversity, dietary diversity and nutritional outcomes in Central Asian context

Objective and research questions

- The study aims to fill this gap by examining the relationship between agricultural diversity, dietary diversity and nutritional outcomes in Tajikistan
- Three interrelated research questions
 - How is agricultural diversity linked with household dietary diversity?
 - Does dominance of cotton and wheat in agricultural production systems affect household dietary diversity?
 - How is household dietary diversity linked with child nutritional outcomes?

Related literature: Dietary diversity

- Dietary diversity (DD) is measured as a count of different food groups consumed over a specified reference period
- DD is widely recognized as an important nutrition indicator (WHO/FAO 2003; Arimond and Ruel 2004; etc.)
- Household DD is strongly correlated with per capita calorie consumption, dietary energy adequacy and nutrition indicators such as anthropometrics (Ruel 2003; Ruel et al. 2013)
- Also DD is a strong predictor of dietary quality in terms of (micro)nutrient intake and adequacy (Ruel et al. 2013)
- Households will only diversify their diets into higher-value micronutrient-rich foods when they have satisfied their basic calorie needs

Related literature: Agricultural diversity

- There is broad literature which claims the importance of agricultural diversity for nutritional outcomes (Allen et al. 2014; Fanzo et al. 2013; Haywood 2012; etc.)
- Agricultural diversification plays an important role in sustaining agriculture-based livelihoods (Jayne et al. 2010; Bigsten and Tengstam 2011)
- Diversification may help to reduce farmers production and market risks and improve household welfare (Fafchamps 1992; DiFalco and Chavas 2009)
- Farmers diversifying toward high-value crops are less likely to be poor (BIRTHAL, Roy and Negi 2015)
- Positive effect of diversification into vegetables for poverty reduction is more pronounced (Weinberger and Lumpkin 2007)

Theoretical considerations

- In case of subsistence agriculture, agricultural diversity of farm households will have direct impact on dietary diversity
- If there is a market, link between agricultural diversity and dietary diversity is not trivial
 - Farm households may aim to maximize their income by allocating land for different crops
 - Tradeoff between specialization and diversification
 - The choice made by farmers ultimately depend on subjective assessment of risk-return tradeoffs

Theoretical considerations (continued)

- Farmers crop choice decisions also depend on
 - Availability of various inputs (seeds, seedlings, fertilizer, chemicals, etc.)
 - Existing institutional arrangements for linking farmers with markets
 - Transaction (transportation) costs for market access
- In some cases, government policies may restrict the choices made by farmers
- If integration across sub-regional markets is weak and transportation costs are high, the diversity of agricultural production systems of individual regions may become an important determinant of household dietary diversity

Empirical methodology

- Two interrelated equations: dietary diversity and nutritional outcomes
- Dietary diversity equation
 - Dependent variables: Count-based HH dietary diversity score and its modifications
 - Key independent variables: agricultural diversity scores at HH and district levels; share of cotton and wheat in total land area at district level
 - Control variables: Household and community characteristics, market access, region and village fixed effects

Empirical methodology (Continued)

- Nutritional outcome equation
 - Dependent variables: Height-for-age z-scores and binary variable for child stunting
 - Key independent variables: Household dietary diversity score
 - Control variables: Child and maternal characteristics, household and community characteristics, region and village fixed effects
 - Impact of dietary diversity on stunting depends on child's age

Empirical methodology (Continued)

- Estimation methods
 - OLS, multilevel mixed effects and nearest neighbor matching methods
- Data sources
 - Tajikistan Living Standards Survey (TLSS) 2007
 - Agricultural households – 3062
 - Households with children under 5 - 2310
 - District level population and land allocation data (Regions of Tajikistan database, National Agency on Statistics, 2011)

Measuring agricultural and dietary diversity

- Dietary diversity
 - Count based household DD score with 12 food groups was developed using FAO's (2011) guidelines
 - Calorie intake and food expenditure based indexes capture richness and evenness
 - Calorie intake and food expenditure based log-abundance indexes capture richness and abundance
- Agricultural diversity
 - Count based household level agricultural diversity score
 - Land allocation based and population-weighted agricultural diversity scores were calculated at the district level
 - Share of cotton and wheat in total sown are at the district level

Descriptive Statistics

Variable	Mean	SD	Min	Max
Stunting	0.37	0.48	0	1
DD (count)	9.35	1.38	3	12
DD (evenness, cal, log)	1.59	0.25	0.40	2.23
DD (evenness, exp, log)	1.77	0.26	0.44	2.35
DD (abundance, cal, log)	3.28	0.68	0.89	6.13
DD (abundance, exp, log)	0.36	0.38	0.72	2.35
Agric. Diversity (HH, normalized)	0.44	0.17	0.08	0.92
Agric. Diversity (District, normalized)	0.92	0.08	0.5	1
Cotton & wheat share (District)	0.57	0.22	0	0.85
Distance to urban center (log)	3.74	1.49	-0.69	5.77
Per capita expenditures (log)	5.02	0.52	3.21	8.45

Regression results: Dietary diversity

	Dependent variable				
	Count-based DD	Calorie-weighted DD	Expenditure-weighted DD	Calorie-based log-abundance DD	Expen.-based log-abundance DD
Agricultural diversity (HH)	0.0518*** (0.0118)	0.0486* (0.0281)	0.0658** (0.0299)	0.1753*** (0.0583)	-0.0150 (0.0261)
Agricultural diversity (district)	0.0124** (0.0056)	0.0487*** (0.0142)	0.0552*** (0.0154)	0.1113*** (0.0288)	0.0838*** (0.0136)
HH expenditure (log)	0.0886*** (0.0070)	0.1524*** (0.0160)	0.1748*** (0.0174)	0.7272*** (0.0476)	0.3976*** (0.0269)
Poor	-0.0200*** (0.0057)	-0.0341** (0.0133)	-0.0417*** (0.0142)	-0.1494*** (0.0322)	-0.0753*** (0.0167)
Location	0.0165*** (0.0061)	0.0578*** (0.0130)	0.0621*** (0.0147)	0.0681** (0.0293)	-0.0020 (0.0137)
HH size	0.0076*** (0.0010)	0.0071*** (0.0024)	0.0057** (0.0025)	0.0008 (0.0049)	-0.0284*** (0.0023)
No of children under 14	0.0032** (0.0015)	-0.0000 (0.0035)	0.0036 (0.0037)	0.0131* (0.0074)	0.0020 (0.0033)
HH head's gender	0.0062 (0.0057)	-0.0109 (0.0122)	-0.0058 (0.0135)	0.0120 (0.0269)	-0.0230** (0.0109)
Distance to oblast center	-0.0066*** (0.0016)	-0.0101*** (0.0034)	-0.0211*** (0.0037)	-0.0252*** (0.0076)	-0.0002 (0.0033)
Grain and Cotton share	-0.0309** (0.0152)	-0.0129 (0.0331)	0.0232 (0.0358)	-0.3142*** (0.0768)	-0.2134*** (0.0366)
Constant	0.2891*** (0.0510)	0.7286*** (0.1210)	0.8661*** (0.1301)	-0.3858 (0.3062)	-1.4914*** (0.1677)
Observations	3,062	3,062	3,062	3,062	3,062
F-test	42.49	22.36	27.66	94.67	190.45
R-squared	0.245	0.1578	0.1565	0.4228	0.6435
Note: Robust standard errors in parentheses; All specifications control for HH and community characteristics, region fixed effects					
*** p<0.01, ** p<0.05, * p<0.1					

Regression results: Child nutrition

	Key Independent variable				
	Count-based DD	Calorie-weighted DD	Expenditure-weighted DD	Calorie-based log-abundance DD	Expen.-based log-abundance DD
Dietary Diversity	-0.3238 (0.3153)	0.2405 (0.1563)	0.1692 (0.1573)	-0.0536 (0.0576)	0.0613 (0.0542)
Child's age in months (log)	0.0555 (0.0786)	0.2282*** (0.0763)	0.2105** (0.0857)	0.0812 (0.0592)	0.1115*** (0.0215)
Interaction of DD with child's age	0.0423 (0.0995)	-0.0878* (0.0486)	-0.0692 (0.0493)	0.0026 (0.0184)	-0.0122 (0.0094)
Child's gender	0.0347* (0.0193)	0.0338* (0.0194)	0.0339* (0.0194)	0.0342* (0.0193)	0.0343* (0.0192)
Mother's height	-0.6525*** (0.1432)	-0.6522*** (0.1431)	-0.6519*** (0.1432)	-0.6549*** (0.1427)	-0.6456*** (0.1441)
HH expenditure (log)	0.0197 (0.0404)	0.0036 (0.0401)	0.0074 (0.0408)	0.0355 (0.0438)	-0.0065 (0.0465)
Poor	0.0174 (0.0335)	0.0168 (0.0336)	0.0172 (0.0336)	0.0137 (0.0334)	0.0180 (0.0334)
Location	-0.0450 (0.0298)	-0.0452 (0.0292)	-0.0432 (0.0293)	-0.0446 (0.0297)	-0.0465 (0.0297)
Total livestock units	0.0044** (0.0018)	0.0040** (0.0018)	0.0040** (0.0018)	0.0043** (0.0018)	0.0045** (0.0018)
Distance to nearest large urban center (log)	0.0193** (0.0091)	0.0189** (0.0090)	0.0188** (0.0091)	0.0192** (0.0091)	0.0191** (0.0091)
Chi-squared test for joint significance	54.9462	59.6255	58.4859	55.1102	53.3205
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Log Likelihood	-1549.4069	-1549.1685	-1549.3735	-1549.1225	-1550.0116
Wald test (full model)	118.77	131.86	125.42	118.42	119.12
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2,310	2,310	2,310	2,310	2,310
Note: Robust standard errors in parentheses; All specifications control for HH and community characteristics, region fixed effects					
Chi-squared tests for joint significance between dietary diversity score, age of child (log), and their interaction					
*** p<0.01, ** p<0.05, * p<0.1					

Summary of key findings

- Key empirical results suggest that
 - Agricultural diversity is positively associated with dietary diversity
 - Dietary diversity is in turn correlated with child nutritional outcomes and this relationship depends on child's age
- Findings also suggest that there is a strong negative association between household dietary diversity and share of land allocated to cotton and wheat at district level
- Households in communities located further away from urban centers tend to have lower dietary diversity

Summary of key findings (cont.)

- These results are robust
 - Across alternative measures of household dietary diversity
 - Changes in estimation techniques
 - Controls for key child, maternal, household and community characteristics

Dietary patterns in Kyrgyzstan (2012)

	Quarter I	Quarter II	Quarter III	Quarter IV
Cereals	100	100	100	100
Roots & tubers	96.8	95.8	94.2	96.4
Vegetables	99	99.3	99.5	99.3
Fruits	64.3	38.3	72.3	67.7
Meat	96.3	95.4	95	96.8
Eggs	57.8	60.3	59.7	57.1
Fish	17	13.6	11.4	15.1
Legumes	14.4	9.8	6.5	11.9
Dairy	76.7	73.9	71.1	73.9
Oils	98.3	97.3	97.4	98.3

Source: KIHS 2012

Dietary patterns in Kyrgyzstan (2013)

	Quarter I	Quarter II	Quarter III	Quarter IV
Cereals	100	100	100	100
Roots & tubers	96.3	95.4	96.6	98
Vegetables	99.5	99.6	100	99.8
Fruits	58.6	41.2	64.1	73.8
Meat	95.9	96	95.8	96.9
Eggs	53.4	59.2	58.9	57.6
Fish	14.2	10.7	11	15.9
Legumes	12.2	8.6	7.1	14.5
Dairy	75.2	74.8	75.9	77.8
Oils	98.5	98.3	99.5	98.7

Source: KIHS 2013

Conclusions and policy implications

- Further promotion of agricultural diversity may be necessary by allocating more land to horticulture and feed crops
 - In some districts up to 85% of arable land is still allocated to cotton and wheat
- Investment in infrastructure is important to promote market integration across different regions of the country
- Regional cooperation and trade in Central Asia is important to ensure food and nutritional security in the region

Thank you!