What matters most for cultivating healthy diets: agricultural diversification or market integration?

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Inertia in LMICs toward increasing i) the **extent of specialization** of smallholder farms, and 2) **orientation toward commercial markets**

Not inherently at odds with preservation of agricultural biodiversity, but genetically uniform production systems often result

**Agricultural biodiversity important** for ecosystem services (e.g., stability, resource use efficiency, pest regulation), and productivity (e.g., via sampling effect, facilitation, seasonal evenness)

Nutritional consequences of changes in agricultural biodiversity, and trade-offs with market integrations are not clear

OBJECTIVE

Through a review of empirical evidence, assess and compare the association of agricultural biodiversity and market access with the quality and diversity of diets of agricultural households in low- and middle-income countries.
METHODS

- Systematic literature review

- 2 independent reviewers examined 5 databases of English-language indexed literature using key search terms identified *a priori*

- Inclusion/exclusion criteria:
  - at least 1 metric of terrestrial, cultivated agricultural biodiversity
  - at least 1 metric of dietary diversity or quality
  - studies exclusively of home gardens were excluded
  - non-empirical theoretical studies or unpublished theses excluded

- Heterogeneity in measurement approaches, indicators, models, correlation measures precluded a quantitative meta-analysis
ARTICLE SCREENING AND EXCLUSIONS

Records identified through database searching \( (n = 1,094) \)

Duplicate records excluded \( (n = 124) \)

Records screened \( (n = 970) \)

Records excluded according to inclusion criteria \( (n = 894) \)

Full-text articles assessed for eligibility \( (n = 76) \)

Studies included in qualitative synthesis \( (n = 16) \)
## SUMMARY OF INCLUDED ARTICLES

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Country</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Ekesa et al. (2008)</td>
<td>Kenya</td>
<td>144</td>
</tr>
<tr>
<td>4. Remans et al. (2011)</td>
<td>Kenya, Malawi, Uganda</td>
<td>170</td>
</tr>
<tr>
<td>5. Keding et al. (2012)</td>
<td>Tanzania</td>
<td>252 women</td>
</tr>
<tr>
<td>6. Oyarzun et al. (2013)</td>
<td>Ecuador</td>
<td>51</td>
</tr>
<tr>
<td>7. Jones (2014)</td>
<td>Bolivia</td>
<td>251</td>
</tr>
<tr>
<td>8. Jones et al. (2014)</td>
<td>Malawi</td>
<td>6,623</td>
</tr>
<tr>
<td>9. Pellegrini et al. (2014)</td>
<td>8 countries</td>
<td>33,119</td>
</tr>
<tr>
<td>10. Remans et al. (2014)</td>
<td>Global</td>
<td>113 countries</td>
</tr>
</tbody>
</table>
DIETARY ASSESSMENT

Measurement approaches

• quantitative 24-hour dietary recalls (5)
• qualitative 24-hour food group recall (2)
• 7-day food frequency questionnaire (2)
• 7-day household food consumption (4)
• instrument not specified (2)

Indicators

• diet diversity score (food groups) (11)
• food variety score (food items) (6)
• Food Consumption Score (2)
• Mean Adequacy Ratio (1)
• Infant and Child Feeding Index (1)
MEASUREMENT OF AGRICULTURAL BIODIVERSITY

Crop count (12)
• food crops only (3)
• horticultural crops only (1)
• non-maize crops (1)
• intercrops (1)

Combined crop count (4)
• crop and livestock (3)
• crop, livestock, and wild collected foods (1)

Evenness indices (4)
• Margalef Index (2)
• Simpson Index (1)
• Shannon Index (1)
MEASUREMENT OF MARKET ACCESS

• 7 studies included some indicator of market access

Production orientation of households
• proportion of food consumed by household from own production (1)
• proportion of cropped land area devoted to market crops (1)
• selling any part of farm produce to the market (1)
• number of vegetable species sold v. purchased (1)
• value of subsistence production (unspecified measurement) (1)

Proximity to locations/services
• distance to nearest road or market (2)
• access to own mode of transport (2)
• community bus stop, rural location, school feeding program in community (1)

Livelihood source
• any income from off-farm/non-farm employment (1)
In 14 of 15 studies, household-level agricultural biodiversity was positively associated with household- or individual-level dietary diversity or quality, independent of household wealth or market access.
<table>
<thead>
<tr>
<th>Study</th>
<th>Magnitude of association</th>
</tr>
</thead>
<tbody>
<tr>
<td>1   Dewey (1981)</td>
<td>adjusted $r = 0.25$ for HH $\geq 5$ crops</td>
</tr>
<tr>
<td>2   Torheim et al. (2004)</td>
<td>$\beta = 0.002$ (for MAR); $\beta = (NS)$ (for FVS, DDS)</td>
</tr>
<tr>
<td>3   Ekesa et al. (2008)</td>
<td>unadjusted $R^2 = 0.485$</td>
</tr>
<tr>
<td>4   Remans et al. (2011)</td>
<td>associations not reported</td>
</tr>
<tr>
<td>5   Keding et al. (2012)</td>
<td>$r = 0.313$ (with DDS); $r = 0.247$ (with FVS); unadjusted</td>
</tr>
<tr>
<td>6   Oyarzun et al. (2013)</td>
<td>unadjusted $R^2 = 0.194$</td>
</tr>
<tr>
<td>7   Jones (2014)</td>
<td>$\beta = 0.04$ (with ICFI)</td>
</tr>
<tr>
<td>8   Jones et al. (2014)</td>
<td>$\beta = 0.23$ (CC with DDS); $\beta = 0.68$ (SI with DDS)</td>
</tr>
<tr>
<td>9   Pellegrini et al. (2014)</td>
<td>$\beta = 0.01$ (DDS, pooled)</td>
</tr>
<tr>
<td>10  Remans et al. (2014)</td>
<td>point estimates for associations not given</td>
</tr>
<tr>
<td>11  Dillon et al. (2015)</td>
<td>log $\beta = 0.24$</td>
</tr>
<tr>
<td>12  Kumar et al. (2015)</td>
<td>$\beta = 0.217/0.250$ (with child/HH DDS)</td>
</tr>
<tr>
<td>13  Malapit et al. (2015)</td>
<td>$\beta = 0.1$ (with maternal DDS); $\beta = 0.06$ (with child DDS)</td>
</tr>
<tr>
<td>14  Sibhatu et al. (2015)</td>
<td>IRR = 1.009/1.054/1.015 (pooled/Indonesia/Malawi)</td>
</tr>
<tr>
<td>15  Snapp &amp; Fisher (2015)</td>
<td>IRR = 1.019</td>
</tr>
<tr>
<td>16  M’Kaibi et al. (2016)</td>
<td>ANOVA: $F = 14.791$</td>
</tr>
</tbody>
</table>
RELATIONSHIP BETWEEN AGRICULTURAL BIODIVERSITY AND DIETARY DIVERSITY

• Magnitude of associations typically small
  – 1 unit increase in agricultural biodiversity associated with 0.1-0.25 increase in DDS
  – 1 unit increase in agricultural biodiversity associated with 1-2% increase in DDS
  – 10 percent increase in agricultural biodiversity associated with 2.4% increase in DDS
RELATIONSHIP BETWEEN MARKET ACCESS AND DIETARY DIVERSITY

• In 5 of 5 studies, greater market access was associated with more positive dietary diversity or quality

• Heterogeneous proxy indicators of market access
  – reliance on own production for consumption (-)
  – selling higher share of production (+)
  – devoting more land to market crops (+)
  – access to public or own transport (+)
  – distance to nearest road or market (-)
  – rural location (-)
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</tr>
</thead>
<tbody>
<tr>
<td>1 Dewey (1981)</td>
<td>adj. $r = -0.44/-0.59$ (value of subsistence production associated with lower dependence on purchased foods)</td>
</tr>
<tr>
<td>5 Keding et al. (2012)</td>
<td>results not shown; women who sold more of their vegetables, had higher DDS and FVS</td>
</tr>
<tr>
<td>6 Oyarzun et al. (2013)</td>
<td>unadj. $R^2 = 0.40$ (CC and number of products destined for family consumption)</td>
</tr>
<tr>
<td>8 Jones et al. (2014)</td>
<td>$\beta = 0.264$ (proportion of cultivated land in market crops); $= -2.64$ (proportion of food from own production) (both CC with DDS)</td>
</tr>
<tr>
<td>12 Kumar et al. (2015)</td>
<td>results not shown; access to own mode of transport independently associated with DDS; inclusion of this variable in regressions did not change coefficient of association btw. agricultural biodiversity and DDS</td>
</tr>
<tr>
<td>14 Sibhatu et al. (2015)</td>
<td>IRR $= 0.999$ (km to nearest market; pooled); $= 1.039$ (any off-farm income); $1.045$ (sell any production)</td>
</tr>
<tr>
<td>15 Snapp &amp; Fisher (2015)</td>
<td>IRR $= 0.997$ (km to nearest road); $= 1.019$ (bus stop in community); $= 1.018$ (school feeding program in community); $= 1.056$ (daily market in community); $= 0.919$ (rural residence); $= 1.049$ (bicycle ownership)</td>
</tr>
</tbody>
</table>
RELATIONSHIP BETWEEN MARKET ACCESS AND DIETARY DIVERSITY

• Magnitude of associations
  – 1 km increase in distance to nearest market or road associated with a 0.1-0.3% decrease in DDS
  – access to market in community, and bicycle ownership associated with a 5.6% and 4.9%, respectively, increase in DDS
  – any off-farm income associated with 3.9% increase in DDS
  – sell any production associated with 4.5% increase in DDS
  – an increase of 1 percentage point in land devoted to market crops associated with 0.26 increase in DDS
**ADDITIONAL FINDINGS**

- Association between agricultural biodiversity and dietary diversity often follows an “inverted U” shape

- Greater production diversity was associated with fewer food purchases, and greater share of consumption from own production

- Total agricultural production and agricultural revenues were positively associated with dietary diversity in several studies, but not as strongly as agricultural biodiversity

- Relationship between agricultural biodiversity and dietary diversity stronger in woman- vs. male-headed households
DISCUSSION

• Consistent positive association between agricultural biodiversity and dietary diversity, independent of wealth and market access; market access has independent positive association with dietary diversity

• Practical meaning of magnitude of associations difficult to compare out of policy context

• Policy implications often indicate an “either-or” approach, though these are not necessarily mutually exclusive approaches

• Just as diversification interventions must account for potential trade-offs and farmers’ capacities, commercialization interventions must address market complementarity

• All diversity is not equal
RESEARCH GAPS

Data quality
• Comprehensive reporting of data (baseline ABD likely affects nature of relationships)
• Longitudinal and quasi-experimental studies

Measurement
• Differences when using food group and evenness indices
• Direct measurement of agricultural biodiversity, including varieties
• Poor proxies for market access
• Limited data on village- or landscape-level agricultural biodiversity
• Challenges with 7-day consumption data as well as dietary diversity

• Limited understanding of mechanisms or the potential moderating influence of agroecological context and place
THANK YOU

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SUPPLEMENTARY INFORMATION
KEY POINTS

- Pooling data across countries may mask important relationships that depend on local agroecological contexts.

- Household wealth and education remain the most important predictor of dietary diversity and quality in most settings.

- At a minimum, interventions must move beyond a focus on increased agricultural production or revenues.
CONCEPTUAL FRAMEWORK ON THE LINKAGES BETWEEN AGRICULTURAL BIODIVERSITY AND DIETARY DIVERSITY

- on-farm crop species richness
  - access to land, productive assets

- quantity of agricultural production
  - food acquisition behaviors; gendered control of income; food availability in markets; food prices

- income

- diversity of market-oriented agricultural production
  - agricultural prices; access to markets, storage, value chains

- diversity of subsistence food production

- food expenditures
  - household wealth; extent of market-oriented production; market access

- quality and diversity of dietary intake

- women’s empowerment
  - access to land, productive assets

- diversity of market-oriented food production
  - household wealth; extent of market-oriented production; market access