Diversified farming, agroecology, and one health: Analyzing strategies for smallholders' food and water security in multihazard environments

11th Annual Stanford Global Health Research Convening Jan. 29, 2025

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AGROECOLOGY CLIMATE RESILIENCE & FOOD JUSTICE

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PRODECOOP

De Campesino a Campesino

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Smallholder Farmers Worldwide

1. 570 million smallholder farmers (5 ha or less) => 2.5 billion people.
2. Manage biodiversity and culturally rich landscapes.
3. Produce >= ⅓ or more of the food that humans eat.
4. Navigate food insecurity, poverty, **water insecurity,** and exclusion in most places.

Source: Lowder, Sánchez, and Bertini 2021

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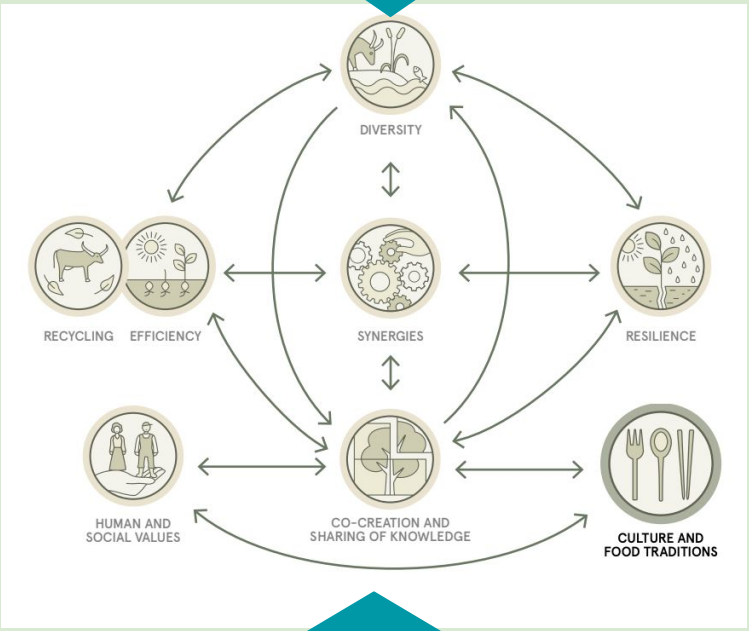
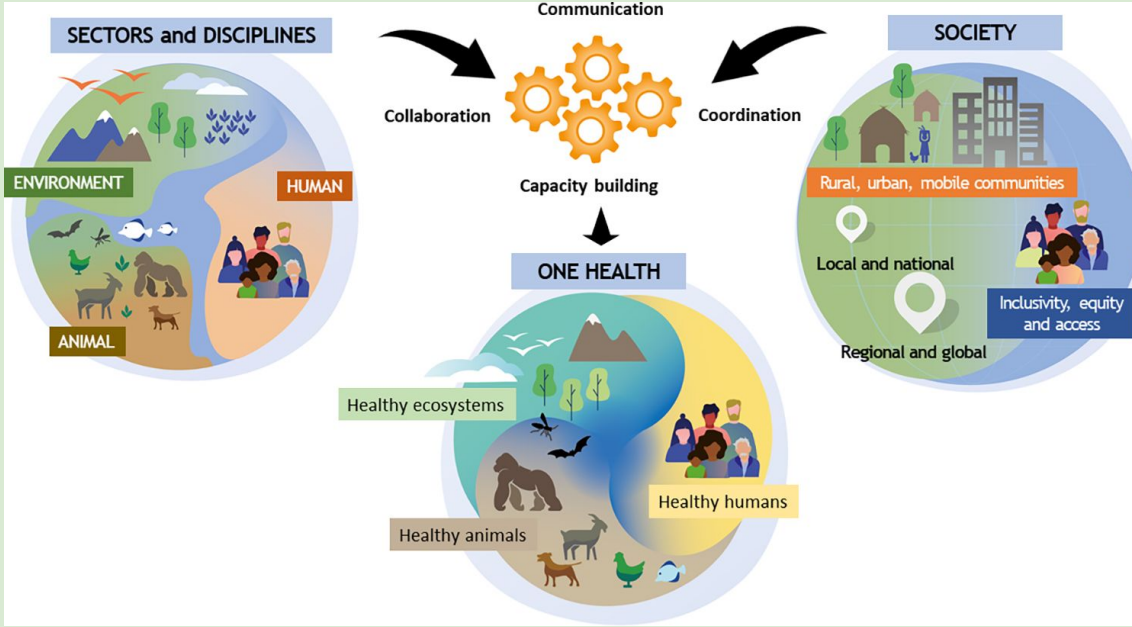
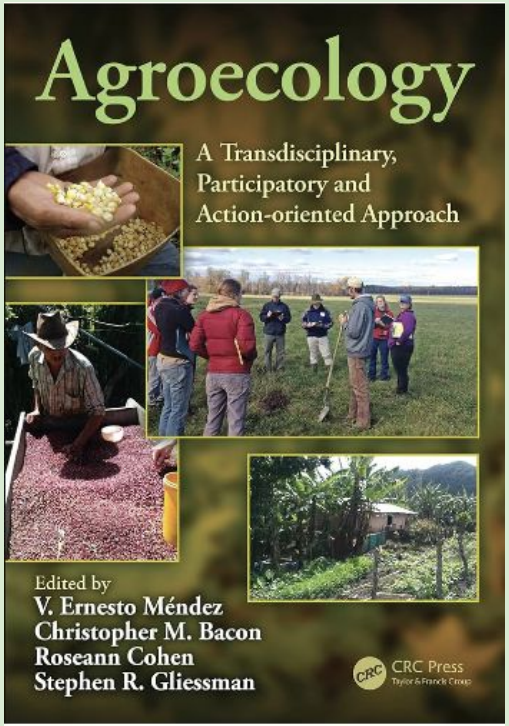
Agroecology + One Health

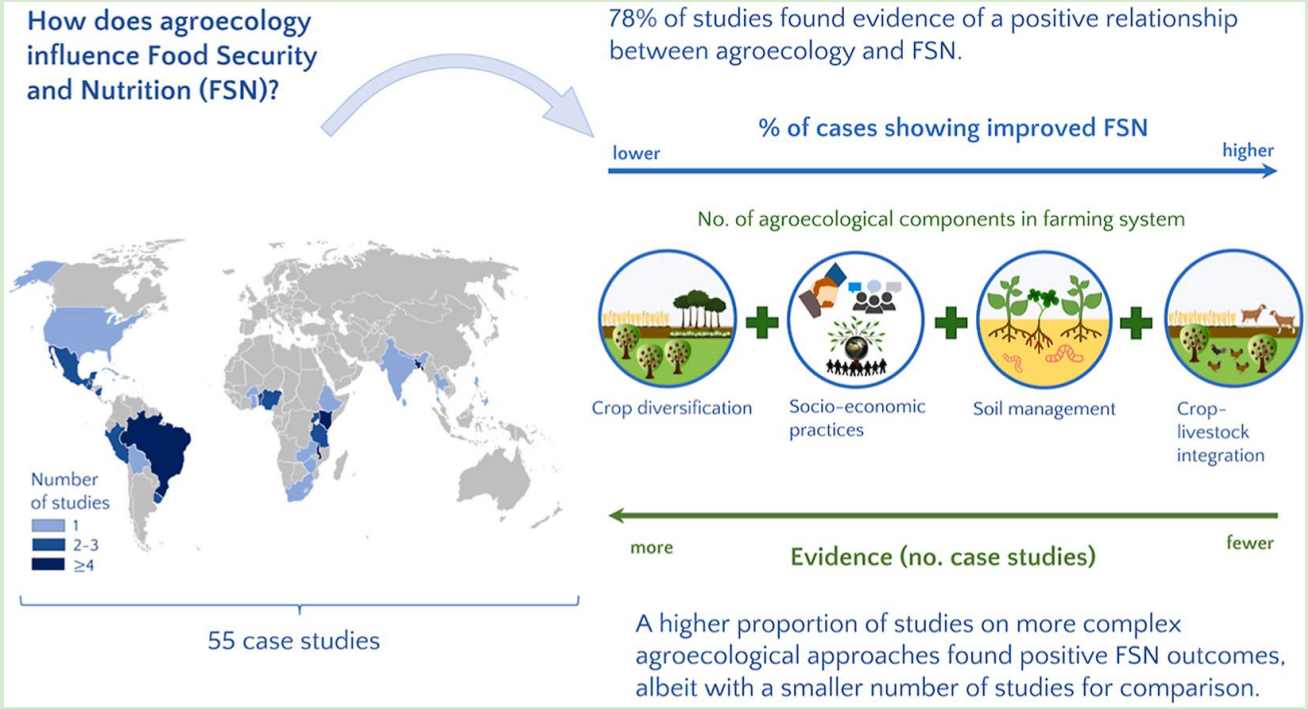




One Health High-Level Expert Panel (OHHLEP), Adisasmito WB, Almuhairi S, Behravesh CB, Bilivogui P, Bukachi SA, et al. (2022) One Health: A new definition for a sustainable and healthy future. PLoS Pathog 18(6): e1010537. https://doi.org/10.1371/journal. ppat.101

FAO. 2019. TAPE Tool for Agroecology Performance Evaluation 2019 – Process of development and guidelines for application. Rome





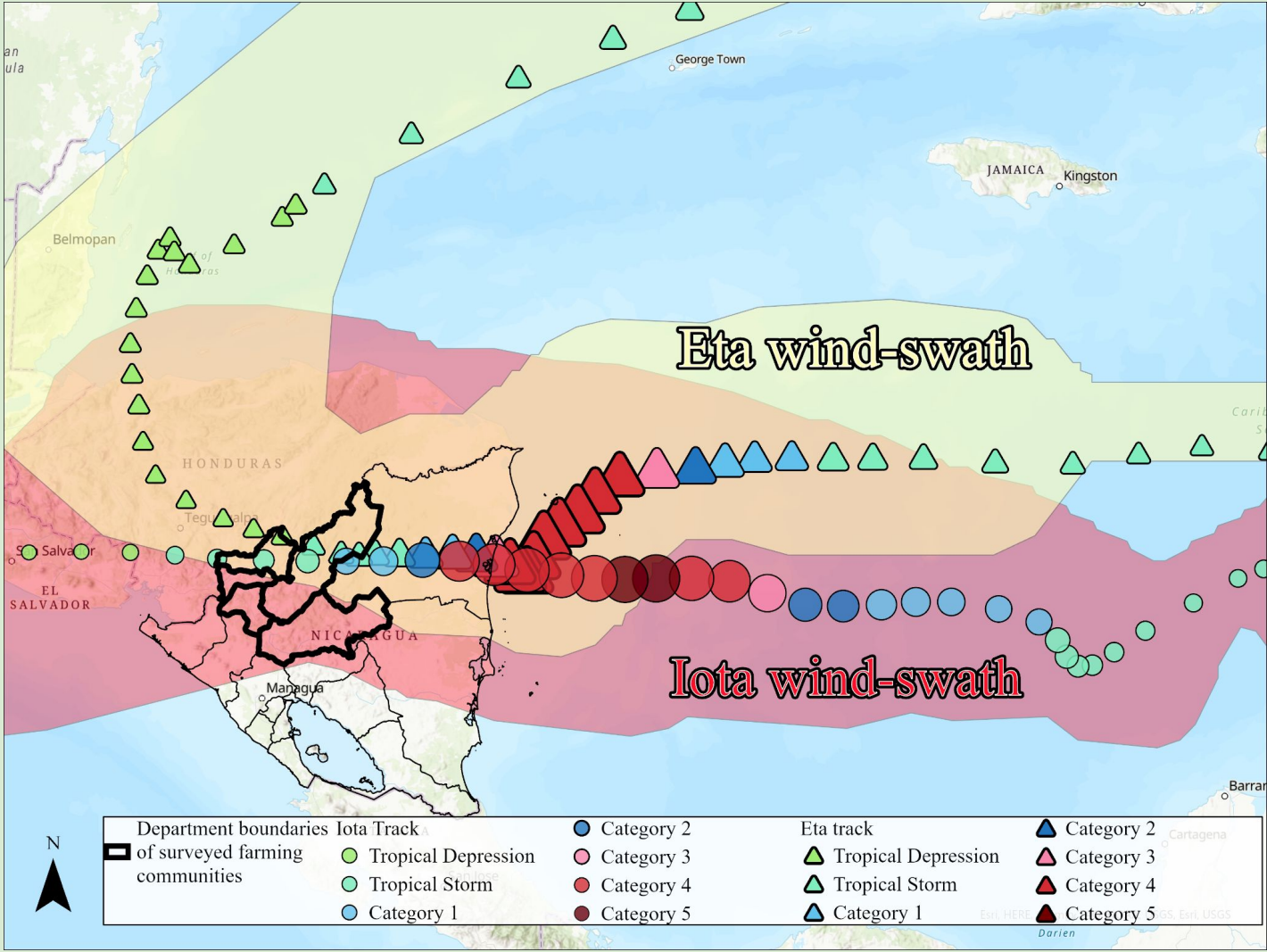
Kerr, R. B., Madsen, S., Stüber, M., Liebert, J., Enloe, S., Borghino, N., ... & Wezel, A. (2021). Can agroecology improve food security and nutrition? A review. Global Food Security, 29, 100540.

Global Gaps and Project Goals

Diversification is key principle in agroecology-based food systems transformations, but gaps exist.

Analyze how different diversification strategies relate to disaster risk, food security, water security, food sovereignty, livelihoods and gender equity, and how this relates to the sustainability of agrifood systems.

Late Season Category 4 and 5 Hurricanes hit Central America in Nov. 2020



Cartography Kylie Griggs (‘22):
Data sourced from ArcGIS Online; DivaGIS

Tropical commodities, diversified farming and study partners

Smallholder coffee Cooperatives

Organic Cacao Co-op, Waslala

Program Campesino-a-Campesino (PCaC)
Organized farmers (30,000 farm households in Nicaragua

Central American Dry Corridor

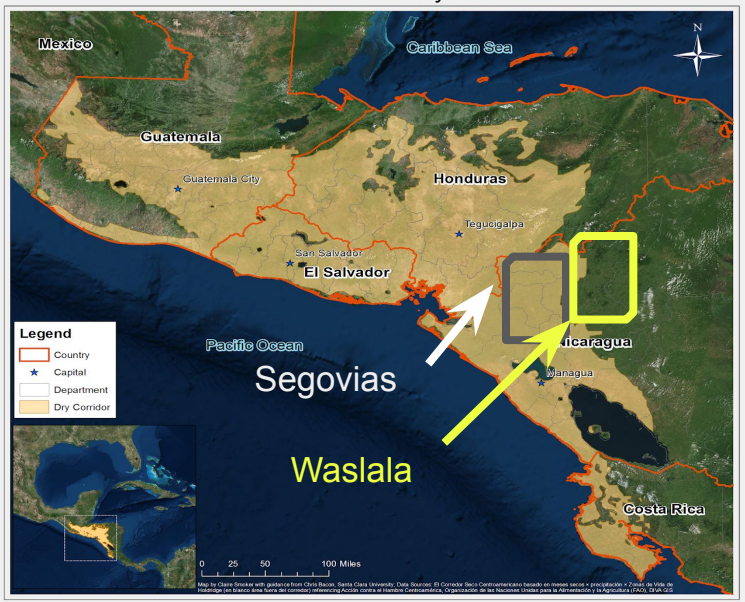


Table 1: Stratified study populations and a randomized sample of small-scale farmer households with affiliations

Region / Municipality	Coffee or Cacao Co-op: Population	Coffee or Cacao Co-op: Sample	UNAG-PCaC: Population	UNAG-PCaC: Sample	Unaffiliated/ other: Sample
Las Segovias					
Telpaneca	91	55	63	14	19
San Lucas	84	30	77	22	33
Pueblo Nuevo	39	16	80	15	7
Las Sabanas	63	21	80	18	19
Jalapa	49	29	0	0	11
Waslala	255	120	N/A	N/A	N/A
Total sample		271		99	89

Notes: Farmers in Las Segovias are affiliated with coffee exporting cooperatives or unaffiliated coffee growers. Farmers in Waslala are affiliated with a cacao exporting cooperative.

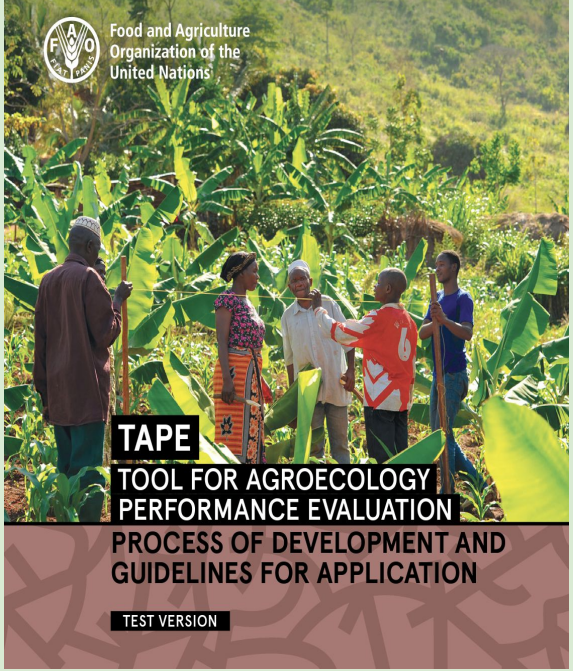
Source: 2022 surveys and cooperative registries.

A Mixed Methods Community-Based Participatory Action Research Approach

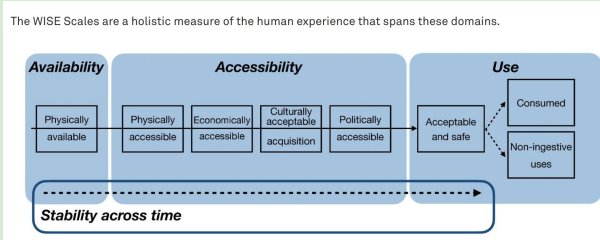
Surveys in 2014, 2017, & 2022

1.5 hours interviews conducted in homes

- Household demographics
- Land tenure, use, and management
- Agriculture and markets
- Livelihood, income and expenses
- Water security
- Food security & sovereignty, dietary diversity
- Agroecology, management, diversification & change
- Participation, gender, and empowerment
- Risks, vulnerability and adaptation



WATER INSECURITY EXPERIENCES (WISE) SCALES

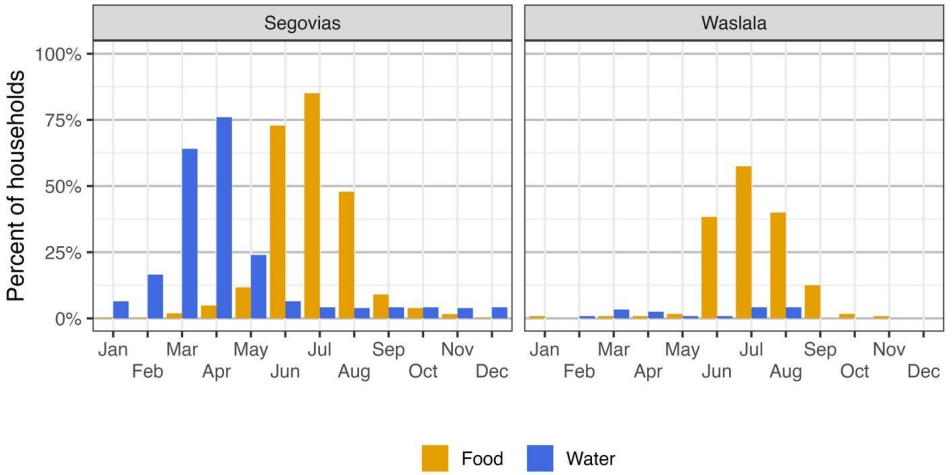


Regional patterns in seasonal food and water insecurity 2022

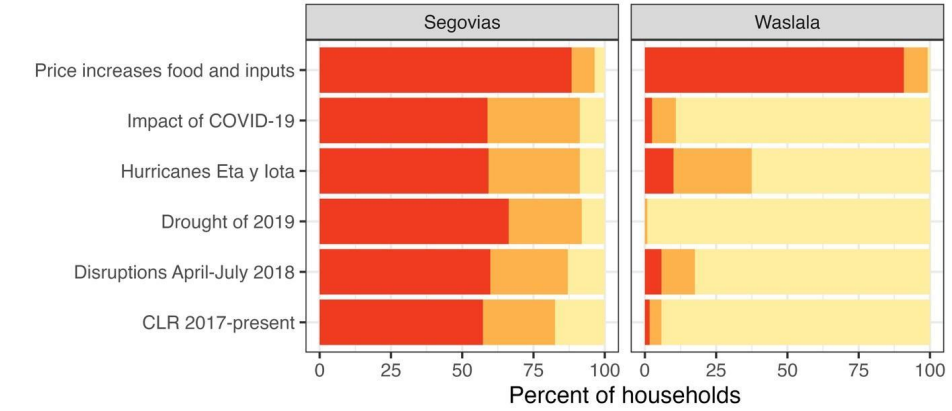
Patterns in hazard impacts

Bacon, C.M. and Sundstrom, W.A. (in review)

(a)



(b)



Source: Household Surveys 2022. n= 429

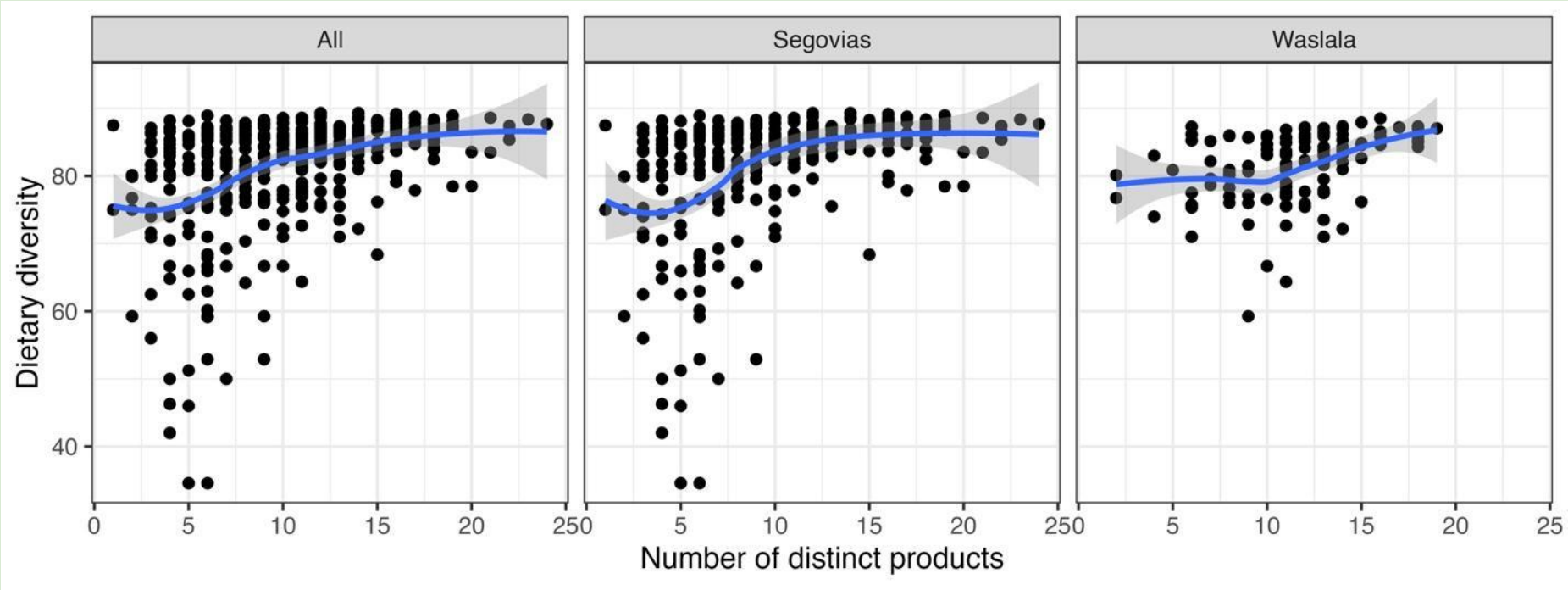
No impact Medium Severe

Farmers' perspectives on diversification

Basic grains [primarily corn and beans] are vulnerable to [surplus] rainfall as well as drought, but through diversification I have crops that are resistant to both conditions. For example, I am going to harvest oranges either way, unless there is a big drought. One has assurance that he has a Plan B. In addition, I consider improvement of the soil to be an important aspect of diversification. We have also started recovering eroded soils that were previously abandoned for lack of harvests."

Source: Interviews 2017 translated: Bacon, Shin, Flores-Gomez, Rivas et al 2022.
Photos used with permission fro PRODECOOP

Farm diversification and dietary diversity by region



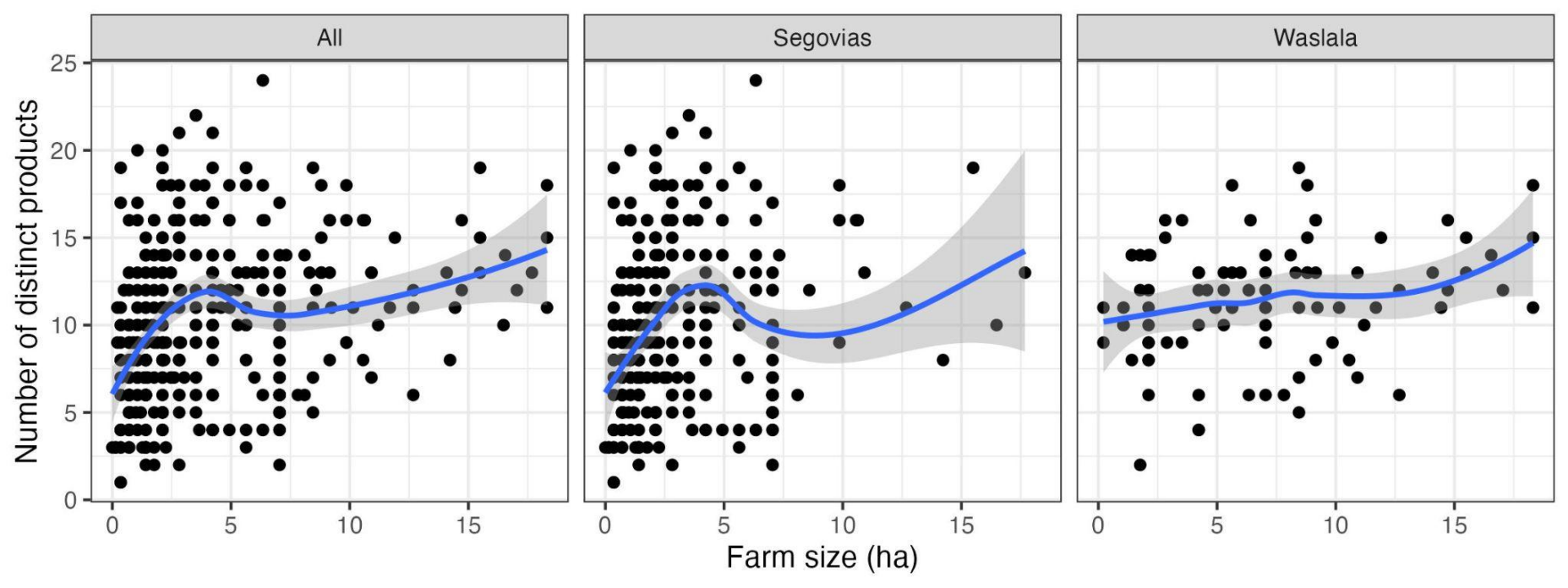
The curved blue lines use loess smoothing. Dietary diversity was measured using the Gini–Simpson (Berry) index of consumption of food groups for a seven-day recall period, scaled to 0–100. Source: Household surveys 2022. n= 424.

Correlates of farm food security and resilience

	Dietary diversity	Food lean months	Hazard severity score	Log of cash income
Waslala	-0.124**	-0.053	-0.682***	-0.173**
Age of respondent	0.103*	0.018	0.073*	-0.090
Respondent educ secondary plus	0.119**	-0.005	-0.049	0.001
Farm size (ha)	-0.060	-0.166***	-0.055	0.325***
Log of cash income last year	-0.057	-0.187***	0.019	
Number of distinct agricultural products	**0.448*** **	**0.089**	**0.073**	**0.288*** **
Number of water lean months	**-0.378*** **	**0.178*** **	**0.109****	**-0.109**
Surplus in both beans and corn	-0.082	-0.110*	-0.050	0.029
Num.Obs.	392	393	393	393
R2 Adj.	0.290	0.162	0.619	0.226

Standardized OLS regression coefficients, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Farm product diversification and farm size



Crop diversity (number of products) increases with farm size for very small farms (up to 5 ha). The curved blue lines use loess smoothing. Source: Household surveys 2022. n= 382.

Conclusions

1. Location less important than surplus corn & bean production, water security, farm size, and income, all significantly correlated with improved seasonal hunger.
2. Agroecological production diversity and farmers' formal education correlated with household dietary diversity (Bezner Kerr et al. 2021; Rasmussen et al. 2024).
3. Stronger partnerships with smallholder organizations *could enhance* diversification and water security to improve dietary diversity and food security.
4. Agroecology approaches can support One Health through diversification, farmer empowerment, decreased agrochemical use, and research interventions for plant, animal and human health.

Export and diversified farming crops in Nicaragua

(Photo credit: Bacon)

Rasmussen, L. V., Grass, I., Mehrabi, Z., Smith, O. M., Bezner-Kerr, R., Blesh, J., ... & Kremen, C. (2024). Joint environmental and social benefits from diversified agriculture. *Science*, *384*(6691), 87-93.

Thank you

DECLARATIONS

Funding and conflicts of interest
This work was supported by the National Science Foundation, United States [BCS 2117976], with additional support from Santa Clara University's College of Arts and Sciences, Office of President and Provost, and the Environmental Justice and Common Good Initiative. The authors have no relevant financial or nonfinancial interests to disclose. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or Santa Clara University.

Ethics approval
The Institutional Review Board of Santa Clara University reviewed and approved this research for ethical conduct involving human subjects. Informed consent was obtained from all individual participants included in the study.

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