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Integrated Value Chain Interventions in Vulnerable Settings

Evidence from Guatemala

Francisco Ceballos
Alvaro Espinoza Hernandez
Manuel A. Hernandez
Cynthia Paz

Markets, Trade, and Institutions Unit

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Francisco Ceballos (f.ceballos@cgiar.org) is a Research Fellow in the Markets, Trade, and Institutions (MTI) Unit of the International Food Policy Research Institute (IFPRI), Washington, DC.

Alvaro Espinoza Hernandez (a.espinozahernandez@colostate.edu) is a PhD Student in the Department of Agricultural and Resource Economics at Colorado State University, Fort Collins, Colorado.

Manuel A. Hernandez (m.a.hernandez@cgiar.org) is a Senior Research Fellow in IFPRI's MTI Unit, Washington, DC.

Cynthia Paz (c.paz@cgiar.org) is a Senior Research Analyst in in IFPRI's MTI Unit, Washington, DC.

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Abstract

Guatemala experiences high and persistent poverty and chronic malnutrition, especially in rural areas of the Western Highlands, where agricultural productivity is low, market integration is limited, and households remain vulnerable to multiple shocks. This paper evaluates the impacts of a regional value chain project combining interventions aimed at strengthening agricultural production, market access, and nutrition-sensitive practices. Using household survey data collected from beneficiary and control households in 2019 and 2022, we assess project impacts on outcomes related to production and income, food security, and nutrition. The findings suggest relatively modest impacts during the evaluation period. The intervention contributed to some degree of agricultural diversification, particularly through increased production of fruits and vegetables, while reducing moderate or severe food insecurity episodes and improving children's weight-for-height z-scores. However, we do not find broader improvements in household expenditures, dietary diversity, or longer-term child nutritional outcomes. Additional analyses reveal limited evidence of meaningful differences in impacts across implementing partners, project components and treatment intensity, household groups, and exposure to specific shocks. These findings highlight the challenges of achieving measurable gains through integrated value chain and nutrition interventions in vulnerable environments and point to the importance of accounting for broader contextual factors in project design and evaluation.

Keywords: Value chain interventions, agricultural diversification, household expenditures, food security and nutrition, rural vulnerability, Guatemala

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1. Introduction

Agriculture remains a central component of Guatemala's economy, employing around one third of the economically active population, and up to 84% in rural areas. Most employment is informal, and the sector has grown more slowly than the overall economy, accounting for less than one tenth of Gross Domestic Product (GDP) (Derlagen et al., 2020; INE, 2021). In the Western Highlands, households are largely dependent on agricultural activities, often at subsistence levels, and the sector employs 56.3% of the labor force, serving as a key source of food security and household income (USAID, 2010). Poverty rates are also high in the region, reaching up to 86% in some departments (INE, 2024). At the same time, the agricultural sector's capacity to support economic development is constrained by small landholdings, limited investment, weak market integration, and inadequate public services and infrastructure, resulting in low agricultural productivity. Despite the expansion of some agricultural exports over the past decade, including coffee and horticultural products, crop diversification is limited and largely concentrated in staple crops such as maize and beans (World Bank, 2016; IFPRI, 2017).

At the same time, chronic malnutrition (stunting) is high in Guatemala, with some of the highest rates observed in the Western Highlands, where stunting affects over 50% of children under five (MSPAS, 2017).[1] Households in the region that rely on agriculture are frequently exposed to climate and other shocks that exacerbate food insecurity and limit dietary diversity. Extreme weather events, pests and diseases, and price fluctuations are common and constrain rural households' ability to invest, generate income, and maintain adequate food consumption in the absence of effective coping mechanisms (FEWS NET, 2016; Ceballos et al., 2024).[2]

In this context, the development of agricultural value chains has been promoted as a pathway to improve livelihoods in the region. Such interventions can, in principle, address multiple supply- and demand-side constraints faced by smallholder farmers (De Janvry and Sadoulet, 2020), including targeted support to producers (e.g., improved inputs, training, and technology), coordination among value chain actors, and improvements in the business environment (Christiaensen and Vandercasteelen, 2019; Swinnen and Kuijpers, 2019; Barrett et al., 2022).

This paper evaluates the Feed the Future (FTF) Guatemala Value Chains Project, which aimed to increase agricultural incomes, strengthen resilience, and improve nutrition among smallholder farmers and their families in the Western Highlands. The intervention combined value chain development with nutrition-sensitive strategies, including the promotion of diversified diets, animal-source foods, and social

[1] Nationally, Guatemala has one of the highest stunting rates in Latin America and the Caribbean, exceeding those of countries with significantly lower per capita incomes, including Bangladesh, Ethiopia, and Vietnam (World Bank, 2016).

[2] At the national level, Guatemala ranks among the countries most affected by climate-related disasters globally (Eckstein et al., 2021).

behavior change communication (SBCC), and emphasized productivity gains, market integration, climate adaptation, and institutional support. Implementation was carried out by Agropecuaria Popoyan S.A. (hereafter Popoyan) and Federación de Cooperativas Agrícolas de Productores de Café de Guatemala (FEDECOCAGUA) across selected municipalities in the region, with each partner adopting distinct value chain approaches while aligning with shared project objectives.

We assess impacts on outcomes related to production and income, food security, and nutrition, using household survey data collected in 2019 and 2022. We also examine heterogeneity in effects across implementing partners, intervention components and treatment intensity, household characteristics, and exposure to weather shocks and input price increases, including major hurricanes and the fertilizer price shock associated with the Russia-Ukraine conflict. Conceptually, the analysis evaluates whether integrating nutrition-sensitive components, including the promotion of animal-source foods and SBCC, into a value chain approach can improve agricultural diversification, household expenditures, dietary diversity, food security, and child nutritional outcomes, measured through height-for-age (HAZ) and weight-for-height (WHZ) z-scores for children under two years old.

Our findings point to relatively modest impacts of the project across outcomes. The intervention is associated with some evidence of agricultural diversification, especially through increased production of fruits and vegetables, reductions in moderate or severe food insecurity episodes, and improvements in children's short-term nutritional indicators (WHZ). However, we do not find broader improvements in household expenditures, dietary diversity, or longer-term child nutritional outcomes (HAZ). Heterogeneity analyses reveal limited evidence of meaningful differences in impacts across project dimensions, household groups, and exposure to weather and price shocks.

This paper contributes to three strands of the literature. First, it contributes to the literature on the impacts of agricultural value chain interventions on smallholder livelihoods and market outcomes. Previous studies have found positive effects of training and extension services on income, production, and market access across a range of settings (e.g., Ashraf et al., 2009; Ito et al., 2012; Ma and Abdulai, 2016; Verhofstadt and Maertens, 2015; Biggeri et al., 2018; Ebata and Hernandez, 2017; Ebata & Huettel, 2019; Chamberlin and Jayne, 2020; Kuijpers, 2020; Kafle et al., 2022; Hossain et al., 2025), with some studies also documenting improvements in food security and dietary outcomes (Salazar et al., 2016; Sibhatu, et al., 2022; Songsermsawas et al., 2023).[3] We provide evidence from a vulnerable region in Guatemala and assess impacts not only on income-related outcomes, but also on agricultural diversification and food security and nutrition.

[3] Using spatially disaggregated data across 37 developing countries, von der Goltz et al. (2020) also show that the diffusion of modern crop varieties during the Green Revolution was associated with sizable reductions in infant mortality, highlighting broader links between agricultural technology adoption and child health.

Second, the study relates to the literature on nutrition-sensitive agriculture by evaluating whether integrating nutrition-related components, including the promotion of animal-source foods and SBCC, into value chain interventions leads to improvements in diets and child nutritional outcomes. Prior studies find that nutrition education can improve dietary diversity and micronutrient intake (Olney et al., 2016; Ruel et al., 2018; Kadiyala et al., 2021; Margolies et al., 2022; Masters et al., 2022; Ahmed et al., 2024), and in some cases reduce maternal underweight or anemia among mothers and young children. Evidence on impacts on anthropometric indicators nevertheless remains limited (Ruel et al., 2018; Bliznashka et al. 2022; Gitter et al., 2022; Haji, 2022; Masters et al., 2022). Related evidence from a review by Sibhatu and Qaim (2018) indicates that while agricultural production diversification may contribute to gains in dietary diversity in some contexts, the average effects tend to be relatively small and not consistently associated with broader nutritional gains. Our results suggest limited transmission from gains in agricultural production and household food security into child nutritional status, consistent with findings such as Rutherford et al. (2016) for Liberia, which document improvements in farm production and household food access but limited effects on child-level outcomes, highlighting the challenges of translating productive gains into better child nutrition, particularly in vulnerable contexts.

Third, the paper provides evidence on the effectiveness of development interventions implemented in a context characterized by multiple overlapping shocks, including the COVID-19 pandemic and other concurrent disruptions such as adverse climatic events and input price shocks. While some of these shocks affected households more widely, others varied in intensity across the sample. We exploit the variation in exposure to weather shocks and input price increases to examine whether these factors influenced project impacts across households. More broadly, the analysis complements a growing literature documenting the disruptive effects of shocks, particularly the COVID-19 pandemic, on agri-food value chains (e.g., Kumar et al., 2020; Mahajan and Tomar, 2020; Rawal et al., 2020; Nchanji et al., 2021; Van Hoyweghen et al., 2021) and on household income and consumption (e.g., Ceballos et al., 2020; Ceballos et al., 2021; Hirvonen et al., 2021; Randell et al., 2021; Husain et al., 2022; Berrospi et al., 2026).

The remainder of the paper is organized as follows. Section 2 provides additional details on the project under evaluation. Section 3 describes the data and main outcomes of interest. Section 4 outlines the empirical strategy. Section 5 presents and discusses the results. Section 6 concludes.

2. Project description

The FTF Guatemala Value Chains Project aimed to improve rural livelihoods and address persistent malnutrition in the Western Highlands through integrated agricultural value chain interventions. Building

on prior initiatives in the region,[4] the Project sought to increase agricultural incomes and strengthen resilience among smallholder farmers and their families, while improving nutrition outcomes. Although the project was launched in 2017, most field activities began in late 2019 following the initial registration of beneficiaries. The project then expanded between 2020 and 2022, coinciding with the onset of the COVID-19 pandemic, which introduced early operational challenges to in-person service delivery. The intervention combined value chain development with nutrition-sensitive strategies, including the promotion of diversified diets, animal-source foods, and social behavior change communication (SBCC). Its core components focused on increasing agricultural productivity and income diversification, expanding market access, strengthening climate resilience, and improving the enabling environment for agricultural development and food security.

Implementation was carried out through two private partners, Popoyan and FEDECOCAGUA, both operating under the project with different implementation models and value chain emphases. Popoyan worked with producers in multiple flagship value chains, including coffee, cardamom, fruits, and vegetables, across 32 municipalities in the departments of Huehuetenango, Quetzaltenango, Quiché, San Marcos, and Totonicapán. FEDECOCAGUA focused primarily on coffee producers, with associated nutrition and income diversification components, reaching 24 municipalities in Huehuetenango, Quiché, and San Marcos.[5] See Appendix Figure A.1 for details on the main activities and interventions by implementing partner and project component.

Popoyan's approach aimed to increase rural incomes, reduce vulnerability to chronic malnutrition, and strengthen resilience to climate-related shocks. Activities targeted both producers and other actors along key value chains and emphasized the dissemination of technologies and management practices, the reduction of logistical and post-harvest constraints, and the strengthening of linkages between producers, input suppliers, buyers, and service providers. The model also included the development of business plans, the provision of investment funds, and the promotion of microcredit to support productive investments. In addition, it promoted regional distribution and logistics systems, including the use of digital platforms such as "Agriconecta" to connect producers to markets, alongside climate-smart agriculture and community-based natural resource management.

FEDECOCAGUA implemented a market-driven approach centered on coffee value chains, complemented by income diversification and nutrition-sensitive interventions. Its strategy emphasized access to higher-value markets, the adoption of improved technologies, and stronger linkages with service providers, including finance, processing, and transportation services, as well as the provision of grants to

[4] One major prior program was the USAID-funded Western Highlands Integrated Program (WHIP), which started in late 2012 and continued until 2017 (see USAID–Measure Evaluation, 2014, 2018).
[5] Although Popoyan's activities extended to departments outside the donor's (USAID) zone of influence, the analysis in this study focuses on municipalities within the zone (Huehuetenango, Quiché, and San Marcos).

support market access. It also promoted job creation and local economic multipliers through the development of service markets and entrepreneurship opportunities.

In sum, across both implementation models, the project sought to address both supply- and demand-side constraints, fostering inclusive agricultural growth while improving household welfare and nutrition outcomes. Conceptually, these interventions were expected to operate through several related pathways. Improvements in agricultural production and market access could increase household income and food access, potentially improving dietary diversity. Nutrition-sensitive activities were intended to complement these economic pathways by promoting improved food consumption practices. These changes could ultimately contribute to better nutritional outcomes, although such effects may take longer to materialize and may be constrained by the broader shocks and vulnerabilities faced by participating households.

3. Data

The analysis relies on data comprising a baseline and an endline survey among randomly selected beneficiary and control households. The baseline survey was conducted in 2019 and the endline survey in 2022. Both surveys were administered in person during the same period of the year (November-December) to avoid seasonal differences.

To minimize spillover effects from project participation while reducing logistical challenges and costs, a clustered sampling strategy was used to select a representative sample of households producing coffee, cardamom, and/or horticultural crops in the departments of Huehuetenango, Quiché, and San Marcos. Because the two implementing partners operate independently, clusters were defined differently for each. For Popoyan, a random sample of communities with at least 20 beneficiary households (as reported by the implementer) was selected, stratified by department. For FEDECOCAGUA, clusters were selected through a two-stage sampling strategy, with an initial selection of farmer associations with at least 50 beneficiary households, followed by a selection of communities served by each selected association.

As the evaluation aimed to measure effects on livelihoods and nutrition outcomes, the sample design prioritized households with individuals relevant for these outcomes. The population of interest therefore comprised households with children in early childhood and pregnant women. Once clusters were selected, all beneficiary households with at least one individual from these target groups were included in the sample, and a random sample was drawn from the remaining listed households in the same communities using beneficiary lists available in early 2019.

Control households were selected using a different approach. To identify households with similar agroecological, socioeconomic, and market access characteristics, and producing similar crops as beneficiary households, communities were selected in neighboring municipalities not targeted by the Project and with coffee, cardamom, and/or horticultural production. At baseline, most identified

beneficiaries had not yet received major project support, as implementation was only just beginning, and the number of beneficiaries eventually increased over time. This further motivated selecting the comparison group outside the municipalities targeted by the Project. Within each community, producers were identified with the assistance of local leaders.

A total of 2,479 households (995 beneficiaries and 1,484 controls) were surveyed at baseline across 91 communities in the three departments. A higher control-to-treatment ratio (approximately 1.5) was targeted due to the expectation of higher attrition among control households, who were not direct beneficiaries and thus more likely to refuse participation in the follow-up survey.

In 2022, the survey team attempted to re-interview all baseline households but successfully reached only 1,462 of them (713 beneficiaries and 749 controls).[6] This panel sample constitutes the main dataset used in the household-level analysis. To partially offset attrition, an additional 484 households (204 beneficiaries and 280 controls) were interviewed in 2022, yielding an expanded cross-sectional sample of 1,946 households across 65 communities in the same departments (see Figure 1). Of the original 91 communities, 26 could not be revisited due to infrastructure and access disruptions that prevented survey teams from reaching some locations and/or refusal by local leaders to participate in the survey; Appendix Table A.1 shows that baseline characteristics were generally comparable between communities revisited in 2022 and those that could not be re-surveyed. For the child-level analysis, we rely on repeated cross-section data using households with at least one child under two years old surveyed at baseline and/or endline, including both panel and non-panel households (652 households in 2019 and 454 households in 2022).[7]

Table 1 assesses the balance of socioeconomic characteristics between beneficiary and control households at baseline for both the panel sample used in the main analysis and the sub-sample of households with children used in the repeated cross-section specifications for child indicators. The variables include demographic characteristics of the household head, household composition, dwelling conditions, access to basic services, asset ownership, and land size. Overall, baseline characteristics are broadly comparable across groups. Most differences are small and not statistically significant, particularly for demographic characteristics and household composition. Only a few differences are observed, mainly in dwelling conditions (finished ceilings and access to drainage), as well as in vehicle ownership and agricultural landholdings among beneficiary households. These differences are accounted for in the empirical analysis by including baseline and endline covariates in the estimated models.

[6] A linear probability model of re-interview status on baseline characteristics and a treatment indicator yields a treatment coefficient that is only weakly significant at the 10% level ($p = 0.096$), suggesting limited evidence of differential attrition.

[7] 8.3% and 9.5% of households include more than one child under two years old in 2019 and 2022, respectively

Appendix Table A.2 compares baseline characteristics between households that attritted and those successfully re-interviewed. Most baseline characteristics are relatively comparable across the two groups, although some statistically significant differences are observed. Attritted households are, on average, younger, more educated, less likely to speak Spanish (and thus more prone to be indigenous), have slightly smaller household sizes, lower rates of finished floors, and lower vehicle ownership. However, the magnitude of these differences is generally moderate.[8] To assess potential differential attrition, we also compare these baseline characteristics separately for beneficiary and control households. None of the interaction coefficients between treatment status and an indicator for whether the household was re-interviewed in 2022 is statistically significant at conventional levels, suggesting no evidence of differential selection on the observed baseline characteristics examined. Joint tests indicate that baseline household characteristics are associated with overall attrition ($p < 0.001$), but do not provide evidence of differential selection between beneficiary and control households ($p = 0.329$).[9] We further assess the sensitivity of the main findings to sample attrition in Section 5.2 using the unbalanced panel sample.

3.1 Outcome variables of interest

The analysis focuses on five outcome dimensions that correspond to the core objectives of the Project, including promoting agricultural diversification, increasing household income, improving diets, reducing food insecurity, and enhancing child nutritional status.

Agricultural production and diversification are captured through an indicator of crop diversification defined as the total number of crops produced by the household in each survey round. Additional indicators identify whether the household produced specific crop groups, including fruits and vegetables, legumes, grains and tubers, coffee, and cardamom. These are binary variables equal to one if the household produced the corresponding crop group. As one focus of the Project is income generation and market access, we also capture market orientation through the share of the main crop production destined for sale (ranging from 0 to 100), based on farmer self-reports for each survey round.

Household income is proxied by daily per capita household expenditure, expressed in constant 2017 PPP US dollars. Total household expenditure aggregates spending across multiple categories, including food, housing, consumer goods and durables, education, and health, based on recall periods that vary by

[8] We also conducted additional checks comparing (i) baseline characteristics between the full 2019 sample and households re-interviewed in 2022, and (ii) 2022 characteristics between re-interviewed households and those newly added in the 2022 survey. In both cases, samples are broadly comparable across observable characteristics.

[9] Appendix Table A.3 presents similar comparisons for baseline outcome variables. Most individual differences are not statistically significant, although panel households report a higher number of crops produced and are more likely to produce fruits and vegetables than households surveyed only in 2019. The difference in attrition-related gaps for coffee production between beneficiary and control households is also marginally significant. Joint tests indicate overall differences between baseline-only and panel households ($p < 0.001$), while the test for differential selection between beneficiary and control households yields $p = 0.338$.

category. Annual household expenditure is first computed and then converted into daily per capita terms by dividing by 365 and adjusting for household size.

Dietary quality at the household level is assessed using the household dietary diversity score (HDDS), widely used in the nutrition literature as a proxy for diet quality (Ruel, 2003; FAO, 2011). In addition, we examine diversity in the consumption of animal-source foods (ASF) and fruits and vegetables (F&V), given their importance for achieving a balanced diet (Murphy and Allen, 2003). The HDDS reflects the number of food groups consumed by a reference member of the household, namely the interviewed individual, over the previous 24 hours across twelve food groups, while the ASF and F&V scores are derived using subsets of food groups related to animal-source foods and fruits and vegetables, respectively. The HDDS includes twelve food groups: cereals and grains; roots and tubers; vegetables; fruits; meats, poultry, and offal; eggs; fish and seafood; legumes and nuts; milk and milk products; oils and fats; sugar; and miscellaneous. The ASF score is constructed using seven food groups (beef and pork meat; poultry; offal; sausages and cold meats; seafood; eggs; and dairy products), and the F&V score includes five groups (vitamin A-rich fruits; other fruits; vitamin A-rich vegetables; green leafy vegetables; and other vegetables). We also construct a dietary diversity indicator for women of reproductive age (15-49 years), which similarly serves as a proxy for diet quality and nutrient adequacy (WHO and UNICEF, 2021).[10] The women's dietary diversity score (WDDS) is based on nine food groups and is measured for the same respondent across survey rounds.

Food security is captured using an indicator based on two of the eight questions from the Food Insecurity Experience Scale (FIES) (Ballard et al., 2013). In particular, we construct a binary variable equal to one if the household reports having experienced moderate or severe food insecurity during the 12 months prior to the survey. The question capturing moderate food insecurity asks whether any household member ate less than they thought they should due to a lack of money or other resources, whereas the question capturing severe food insecurity asks whether any household member was hungry but did not eat for the same reason.

Finally, child nutritional status is measured using standardized anthropometric indicators for children under 24 months of age, based on height-for-age (HAZ) and weight-for-height (WHZ) z-scores constructed using WHO reference standards (WHO, 2006). The HAZ reflects the distance, in standard deviations, of a child's height from that of a reference child of the same age and sex, with values below -2 indicating stunting, and is commonly interpreted as an indicator of longer-term nutritional deprivation. The WHZ captures the deviation in weight relative to a reference child of the same age and sex, with values

[10] See Leroy et al. (2015) for a detailed review of food access and dietary diversity indicators.

below -2 indicating wasting. In contrast to HAZ, WHZ does not necessarily reflect a prolonged situation of nutritional deprivation and is generally interpreted as an indicator of acute or shorter-term malnutrition.

Table 2 presents baseline summary statistics for the outcome variables.[11] Baseline values suggest relatively low levels of agricultural diversification and household expenditure across the sample, with households producing approximately two crops on average and daily per capita expenditure of 1.28 US dollars. Coffee and cardamom production are more prevalent among beneficiary households, whereas control households exhibit higher participation in the production of staple crops such as grains, tubers, and legumes. Dietary diversity indicators remain moderate overall, with households consuming approximately 6.7 out of 12 food groups on average. Child anthropometric indicators point to nutritional deficits relative to the WHO reference population for height-for-age z-scores (HAZ), which average -1.80 among children under two years old.

4. Methodology

We estimate project impacts using a differences-in-differences (DID) framework that compares changes in outcomes between 2019 and 2022 for beneficiary and control households. The baseline specification is,

$$Y_{it} = \alpha + X_{it}\beta + \gamma T_i + \eta R_t + \delta(T_i \times R_t) + \nu_i + \varepsilon_{it} \quad (1)$$

where Y_{it} is the outcome for household i at time t; X_{it} is a vector of time-varying household characteristics (see Table 1); T_i is an indicator equal to one for beneficiary households; R_t is an indicator equal to one for observations in the endline survey (2022); ν_i denotes household fixed effects that absorb time-invariant observed and unobserved heterogeneity (including the main treatment indicator); and ε_{it} is an idiosyncratic error term. The parameter of interest is δ, which captures the average treatment effect on the treated (ATT). This specification is applied to all outcomes observed for the same household across survey rounds, including the women's dietary diversity score (WDDS) measured for the same respondent over time.

For child outcomes (anthropometry measurements), the panel structure cannot be exploited because children observed at baseline are no longer in the same age group at endline. We therefore estimate a repeated cross-section version of the model,

$$Y_{it} = \alpha + X_{it}\beta + \gamma T_i + \eta R_t + \delta(T_i \times R_t) + A_m + \varepsilon_{it} \quad (2)$$

[11] To reduce the influence of outliers, observations with unusually large or small values for specific outcome variables are excluded only from the corresponding outcome calculations and regressions. For household expenditure, we exclude observations with changes below the 1st percentile and above the 99th percentile of the distribution of expenditure changes between survey rounds. For anthropometric indicators, children with biologically implausible HAZ values below -6 or above +6, or WHZ values below -5 or above +5, were excluded.

where A_m denotes community fixed effects that capture time-invariant factors at the community level. In the estimation of equations (1) and (2), standard errors are clustered at the community level to account for within-community correlation in outcomes.

We also assess heterogeneous effects by extending the baseline DID specifications to include interactions between the DID term and group-specific indicators. We separately consider heterogeneity by implementing partner (Popoyan, FEDECOCAGUA), project components (Agricultural productivity and income generation, Market access, and Food security and nutrition), household characteristics (household head gender, age and education, household size, landholding size, and location), and exposure to shocks (climatic shocks and fertilizer price increases). For expositional simplicity, we present the extension for equation (1),

$$Y_{it} = \alpha + X_{it}\beta + \gamma T_i + \eta R_t + \delta(T_i \times R_t) + \theta G_i + \lambda(T_i \times R_t \times G_i) + \nu_i + \varepsilon_{it} \quad (3)$$

where G_i denotes the relevant group indicator, θ captures baseline differences across groups, and λ captures differential treatment effects across groups.[12] Analogous specifications are estimated for the repeated cross-section model in equation (2), replacing household fixed effects with community fixed effects.

In the case of impacts by project component, since the three components are non-mutually exclusive such that a household may participate in more than one component, we estimate specifications that include indicators for participation in each of the components and their interactions with the post-intervention period. Specifically, we estimate,

$$Y_{it} = \alpha + X_{it}\beta + \sum_{j=1}^{3} \gamma_j C_{ji} + \eta R_t + \sum_{j=1}^{3} \delta_j (C_{ji} \times R_t) + \nu_i + \varepsilon_{it} \quad (4)$$

where C_{ji} is a binary indicator equal to one if household i participated in component j, for $j = 1,2,3$, corresponding to Agricultural productivity and income generation (Component 1), Market access (Component 2), and Food security and nutrition (Component 3). The coefficients δ_j capture the average effect on Y_{it} associated with participation in component j. We test the equality of these coefficients to assess differences in component-specific effects.

We additionally examine whether impacts vary with the intensity of project exposure, measured by whether beneficiary households received support under only one project component or under multiple components. For this purpose, we estimate a version of equation (3) in which G_i is defined as an indicator

[12] Household-group indicators are defined using baseline characteristics. In the household fixed-effects specifications, the main group indicator is absorbed by the fixed effects.

equal to one for households receiving more than one component. In this case, the coefficient δ captures the effect for beneficiary households receiving support under only one component, while λ captures the differential effect associated with participation in multiple project components.

In our empirical approach, identification relies on the assumption that, in the absence of the intervention, outcomes for beneficiary and control households would have followed parallel trends.[13] Although comparable pre-treatment survey data are not available, Appendix Figure A.2 provides suggestive evidence on pre-treatment dynamics for available indicators using auxiliary household survey data aggregated at the municipality level. The figure shows generally similar trends between treated and control municipalities for household consumption, women's dietary diversity, and child nutritional indicators prior to the implementation of the project. For the height-for-age z-score (HAZ), control municipalities exhibit a somewhat steeper improvement before the intervention period, which, if persistent, would likely bias DID estimates downward rather than overstate positive project impacts. Because these data were collected using different instruments, sampling procedures, and community coverage within municipalities than the survey data used in the main analysis, the evidence should be interpreted as descriptive rather than as a formal test of the parallel trends assumption.

5. Results

This section presents and discusses the evaluation results. We first present the baseline results for the effects of the project on the outcomes of interest. We then assess the robustness of the findings and explore heterogeneity in impacts by implementing partner and intervention type, household characteristics, and exposure to additional shocks. All indicators at the household level are based on longitudinal panel data, following equation (1), while those at the children level are based on repeated cross-section data, following equation (2), as explained in Section 4.

5.1 Baseline results

The estimation results are presented in Tables 3 to 5, where the coefficient on the interaction between treatment status and the 2022 indicator represents the average treatment effect on the treated (ATT). Table 3 reports the estimated impacts on agricultural production and household expenditure outcomes.

One of the central objectives of the project consisted in promoting agricultural diversification and the adoption of higher-value crops through training, technical assistance, and market-oriented support.

[13] As discussed by Abadie (2005), the DID framework identifies the ATT under a set of assumptions. In addition to parallel trends, these include the absence of anticipatory behavior and stable treatment assignment over time. In our context, these assumptions are plausible given the timing of project implementation and the selection of control households from municipalities not directly targeted by the intervention.

Results in Table 3 indicate a small increase in the number of crops produced by beneficiary households, significant at the 10% level. Relative to the baseline control mean, the estimated coefficient implies an increase of about 5% in the number of crops cultivated. Disaggregated results further show positive impacts on the likelihood of producing fruits and vegetables and cardamom, with estimated increases of 5.7 and 2.3 percentage points, respectively. These effects correspond to increases of approximately 34% and 15% relative to baseline control means. By contrast, we do not observe statistically significant impacts on the production of grains and tubers, legumes, or coffee.

We also assess whether the observed changes in production patterns translated into greater market participation. To capture this dimension, we use the share of the household's main crop production destined for sale as a proxy for commercialization intensity. The estimated coefficients are positive but imprecisely estimated and not statistically significant, suggesting that the project did not generate measurable increases in market-oriented production during the evaluation period.

Despite some evidence of increased crop diversification, we do not find statistically significant impacts on household daily per capita expenditure, suggesting limited effects on broader income-related outcomes among beneficiary households during the study period.[14] Taken together, the findings from Table 3 suggest that the intervention contributed to some adjustments in agricultural production patterns, yet these changes did not translate into measurable improvements in commercialization intensity or household economic welfare during the evaluation period.[15]

Table 4 presents the results for household and women's dietary diversity indicators and food insecurity. We do not observe significant effects on the Household Dietary Diversity Score (HDDS), the animal-source food (ASF) score, the fruits and vegetables (F&V) score, or the Women's Dietary Diversity Score (WDDS). Thus, changes in agricultural production did not translate into measurable improvements in dietary diversity outcomes at either the household or women's level. We do, however, find a significant reduction in the prevalence of moderate or severe food insecurity episodes among beneficiary households. The estimated coefficient implies a decrease of approximately 12.5 percentage points, corresponding to a reduction of approximately 31% relative to the baseline control mean. This finding suggests that the project may have contributed to reducing the frequency or severity of food access constraints experienced by beneficiary households, even in the absence of broader improvements in dietary diversity. The result is particularly relevant given the vulnerable context in which the intervention was implemented and evaluated.

[14] Results are qualitatively similar when using the natural logarithm of daily per capita expenditure as the outcome variable.

[15] Although not reported, we similarly do not find significant project impacts on poverty prevalence or on the intention to emigrate among household members that can be viewed as a proxy for local economic conditions relative to relocating.

Table 5 reports the estimated effects on child anthropometric outcomes among children under two years old. We find a positive impact on weight-for-height z-scores (WHZ), with an estimated effect of approximately 0.47 standard deviations, roughly equivalent to the baseline mean among control households. At the same time, we do not find significant effects on height-for-age z-scores (HAZ). Hence, while the project shows some improvements in short-term nutritional outcomes, these effects did not translate into broader gains in longer-term child linear growth over the evaluation period.[16] Given the repeated cross-section nature of the analysis, these findings for children should still be interpreted with caution.

In sum, the results suggest relatively modest and uneven impacts of the project during the evaluation period. While the intervention contributed to some adjustments in agricultural production patterns and improvements in food security-related outcomes, these effects did not translate into broader gains in household economic welfare, dietary diversity, or longer-term nutritional indicators.

These findings are broadly consistent with insights from a complementary qualitative performance evaluation conducted alongside the project implementation (IFPRI, 2022). This assessment highlighted that interventions under the agricultural production component concentrated heavily on horticulture and high-value crops such as tomato, avocado, and cardamom, which aligns with the observed increase in crop diversification among beneficiary households. The qualitative evidence also pointed to persistent constraints in connecting smallholder farmers to stable and modern markets, including limited technical assistance on commercialization and insufficient market linkage mechanisms, which may help explain the absence of measurable impacts on sales and household expenditure outcomes. Finally, the evaluation documented operational constraints faced by field technicians, including limited personnel and the large territories covered by the project. These constraints were compounded by disruptions associated with COVID-19, which reduced the intensity and continuity of project interventions, particularly nutrition-sensitive interventions and household follow-up activities.

5.2 Robustness checks

We conduct several robustness checks to assess the sensitivity of the main findings to multiple inference concerns, alternative specifications, and sample composition.

First, given the multiple hypotheses examined across different outcome dimensions, Appendix Table A.4 reports Romano and Wolf (2005) adjusted p-values to control the family-wise error rate. Adjusted p-values are computed separately for household expenditure and agricultural production indicators in Panel A, dietary diversity and food insecurity indicators in Panel B, and child anthropometric outcomes in Panel

[16] Additional results show no significant impacts on the prevalence of wasting (WHZ < -2), overweight (WHZ>2), and stunting (HAZ < -2) among children.

C, corresponding to the groups of indicators reported in baseline Tables 3-5. The adjusted p-values remain largely consistent with the baseline results and support the main findings.

Second, we estimate weighted DID models using the multiple-group propensity score weighting approach proposed by Stuart et al. (2014), which helps account for potential differences in observable characteristics and changes in sample composition across treatment and control groups over time.[17] This approach classifies observations into four groups defined by treatment status and survey period (treated/control and pre/post), and estimates a multinomial logit model to predict group membership. Weights are constructed as the inverse probability of belonging to the observed group relative to the probability of being in the treated group in the pre-treatment period, allowing observations to be reweighted to improve comparability across groups.[18] All covariates included in the baseline specification are used in the estimation of the propensity scores. Similarly, we estimate DID models on a matched sample of beneficiary and control households using one-to-one propensity score matching with replacement, based on a logistic regression of treatment status on baseline characteristics. Matching is performed imposing common support to ensure overlap between groups.[19]

Appendix Tables A.5 and A.6 report the weighted (Panel A) and matching (Panel B) DID results for household expenditure and agricultural production indicators, and for household and women's dietary diversity and food insecurity indicators, respectively. These models are implemented only for outcomes estimated using the panel specification, as the repeated cross-section analysis for child outcomes relies on different households and children across survey rounds.

The alternative specifications yield results broadly consistent with the baseline estimates. Across both the propensity score weighting and matching DID models, we continue to find positive effects on the likelihood of producing fruits and vegetables, with estimated increases ranging between 5.4 and 6.5 percentage points. The estimated effects on cardamom production also remain positive, with increases between 2.6 and 2.7 percentage points, although statistical significance is comparatively weaker. Similarly, the reduction in the prevalence of moderate or severe food insecurity remains robust across both alternative estimators, with estimated effects ranging from 13.9 to 14.5 percentage points, close to the magnitude obtained in the main specification. By contrast, the positive effect on the number of crops produced loses significance, indicating that evidence on broader crop diversification is comparatively weaker and more

[17] For applications of this methodology, see Saldivar-Frausto et al. (2022) and Wang et al. (2023).
[18] For technical details on inverse probability weighting regression adjustment estimator (IPWRA), see Wooldridge (2007, 2010). Wooldridge (2007) characterizes general conditions and applications of this estimator and extends the result from Scharfstein et al. (1999), requiring that at least one of the models (outcome or treatment) be correctly specified to consistently estimate treatment effect parameters, a property referred to as "doubly robust" (Robins and Rotnizky, 1995).
[19] To preserve sample size and precision, we do not impose additional restrictions on the distance between propensity scores and match each treated unit to its nearest neighbor.

sensitive to specification choice. Overall, these findings reinforce the robustness of the main conclusions regarding production shifts toward higher-value crops and improvements in food security outcomes.

Finally, to assess the sensitivity of our results to sample attrition, we re-estimate the main specifications using the unbalanced panel sample and replacing household fixed effects with community fixed effects, as in the repeated cross-section specification. As observed in Appendix Tables A.7 and A.8, the positive effect on fruits and vegetables production (6.3 percentage points) and the reduction in moderate or severe food insecurity (13.2 percentage points) remain statistically significant and of comparable magnitude to the baseline estimates. By contrast, the estimated effects on crop variety and cardamom production lose statistical significance, consistent with the weaker evidence for these outcomes observed in the alternative model specifications. While these results provide some reassurance regarding the sensitivity of the main findings to sample composition, they do not fully rule out potential bias from non-random attrition.

5.3 Heterogeneity analysis

In the following subsections, we perform a series of heterogeneity analyses by project implementation, intervention type and intensity, household characteristics, and exposure to specific shocks. Given the large number of outcomes examined, the heterogeneity analysis focuses on a subset of core indicators covering the main outcome dimensions. These include the number of crops produced, daily per capita household expenditure, household dietary diversity score (HDDS), moderate or severe food insecurity, and child anthropometric indicators (HAZ and WHZ).

5.3.1 Implementing partner and project component

Among beneficiary households included in the heterogeneity analysis samples, 49.8% received support from Popoyan and 50.2% from FEDECOCAGUA. Participation across project components was non-mutually exclusive, with 92.8%, 51.0%, and 76.1% of beneficiary households receiving support under Components 1 (Agricultural productivity and income generation), 2 (Market access), and 3 (Food security and nutrition), respectively.[20]

Table 6 reports heterogeneous impacts by project implementing partner. The estimated differential effects for Popoyan relative to FEDECOCAGUA are statistically insignificant for household expenditure, dietary diversity, food insecurity, and child anthropometric indicators. An exception is the number of crops produced, where the positive effect observed in the baseline specification appears to be concentrated among

[20] This classification is based on updated administrative records provided by the implementing partners, detailing beneficiary participation in workshops, trainings, and other project activities associated with the three main project components.

households supported by FEDECOCAGUA. The estimated differential coefficient for Popoyan is negative and significant, implying no measurable increase in crop diversification among beneficiary households supported by this implementing partner.

Table 7 presents varying impacts by project component and includes pairwise tests of equality across component-specific treatment effects. The results do not point to substantial differences across components for most outcomes examined. More specifically, we do not find significant differential effects across components for crop diversification, dietary diversity, food insecurity, or child anthropometric indicators. For food insecurity, the largest reduction is observed among households receiving support under Component 1 (Agricultural productivity and income generation), although the equality tests indicate that the estimated effects are not statistically different from those associated with the other two components.

An exception emerges for household daily per capita expenditure, where the estimated coefficients differ across components. Households receiving support under Component 1 exhibit a positive effect significant at the 10% level, whereas households participating in Component 3 (Food security and nutrition) show a negative effect of similar magnitude. These differences are further confirmed by the equality test, which rejects equality between the effects associated with both components. The positive expenditure effect associated with Component 1 is consistent with the productive and income-generation orientation of this component, whereas the negative coefficient for Component 3 may reflect the comparatively stronger focus of this component on food security and nutrition-related support rather than income-generating activities.

Turning to potential treatment intensity effects, Table 8 explores whether impacts differ between beneficiary households receiving support under only one project component and those participating in multiple components. The results do not indicate statistically significant differential effects associated with broader exposure to project components for crop variety, household expenditures, dietary diversity, or food insecurity. Some heterogeneous patterns are nevertheless observed for child anthropometric indicators. More specifically, participation in multiple project components is associated with a marginally significant positive differential effect on height-for-age z-scores (HAZ), while the estimated positive effect on weight-for-height z-scores (WHZ) observed among households receiving support under only one component is attenuated among households participating in multiple components. Together, these findings provide limited evidence that broader exposure to project components generated systematically stronger impacts over the evaluation period.

5.3.2 Household characteristics

Appendix Table A.9 presents heterogeneous impacts by household characteristics. The table examines heterogeneity by gender of the household head, household head age above the sample median, completion of primary education or above by the household head, household size above the sample median, agricultural

landholding size above the sample median, and household location in San Marcos department. The strongest differences emerge across departments. Relative to households located in Huehuetenango and Quiché, beneficiary households in San Marcos exhibit a larger increase in crop diversification, but weaker improvements in household dietary diversity, food insecurity (marginally significant), and child height-for-age z-scores (HAZ). These patterns may reflect differences in local implementation conditions, agroecological characteristics, and the fact that San Marcos is generally more economically and commercially integrated than the other two departments.

Differences also emerge by household size. Larger households exhibit stronger reductions in food insecurity episodes, but marginally weaker improvements in WHZ and somewhat stronger improvements in HDDS relative to smaller households. This may imply differences in household consumption patterns and resource allocation across households of different size. By contrast, heterogeneity by gender of the household head, educational attainment, and age of the household head is more limited, with only isolated differences across outcomes. Male-headed households exhibit relatively stronger improvements in HDDS, households with older heads show weaker impacts on crop diversification, and households with more educated heads exhibit stronger gains in WHZ. We do not observe differential impacts by landholding size across the outcomes examined.

5.3.3 Exposure to shocks

Lastly, we explore differentiated project effects by exposure to specific shocks during the implementation period. The project was carried out in a context characterized by multiple overlapping shocks affecting rural households in Guatemala. In addition to the COVID-19 pandemic, which broadly affected beneficiary and control households alike, several shocks varied in their intensity across households and locations. These included the tropical storms ETA and IOTA (November 2020) and Julia (October 2022), which caused significant flooding, landslides, and agricultural losses across large parts of the country (IFRC, 2022; IFRC, 2023), as well as sharp increases in fertilizer (and other input) prices following the onset of the Russia-Ukraine conflict in early 2022.[21]

Table 9 presents heterogeneous impacts by exposure to these shocks. The indicator for exposure to tropical storms is based on household reports in the endline survey that ETA, IOTA, or Julia affected their crop production, with 44.3% of households reporting being affected by at least one of these storms. The fertilizer price spike indicator identifies households reporting fertilizer price increases between baseline and endline in the upper tercile of the distribution, corresponding on average to a doubling of fertilizer prices; since increases in fertilizer prices were widespread during this period, this measure should be

[21] See IFPRI's special series of blog posts, briefs, and events on the global repercussions of the Russia–Ukraine conflict on food and agricultural markets: https://www.ifpri.org/spotlight/food-prices-war-ukraine (accessed on May 2026).

interpreted as a proxy capturing differential intensity of exposure to input price increases across households rather than objective local price variation.

The results provide very limited evidence of heterogeneity by exposure to shocks. The main differential effect emerges for household dietary diversity (HDDS), where households affected by tropical storms exhibit relatively stronger improvements compared to less affected households. One possible explanation is that areas more heavily affected by storms may also have received additional emergency support or complementary assistance during recovery periods, yet we do not observe corresponding differential effects for food insecurity, expenditures, crop diversification, or child anthropometric outcomes. Exposure to fertilizer price increases does not appear to generate significant differences in treatment effects across the outcomes examined.

6. Concluding remarks

This paper evaluates the impacts of the FTF Value Chains Project implemented in the Western Highlands of Guatemala on agricultural production, household expenditures, dietary diversity, food security, and child nutritional indicators. The project combined interventions aimed at strengthening agricultural production, market access, and nutrition-sensitive practices in vulnerable rural communities. We employ a differences-in-differences approach using household survey data collected from beneficiary and control households in 2019 and 2022.

The findings suggest relatively modest impacts of the project during the evaluation period. The intervention contributed to some degree of agricultural diversification, particularly through increased production of fruits and vegetables, while reducing the prevalence of moderate or severe food insecurity episodes and improving weight-for-height z-scores (WHZ) among young children. At the same time, these changes did not translate into broader improvements in household expenditure, dietary diversity, or longer-term child nutritional outcomes. Additional analyses exploring heterogeneity by implementing partner, project component and treatment intensity, household characteristics, and exposure to specific shocks provide limited evidence of systematic differences in impacts across groups. Although the empirical strategy and multiple robustness checks strengthen confidence in the findings, we acknowledge that the quasi-experimental nature of the evaluation does not allow us to fully rule out the influence of all unobservable factors over time.

The results are broadly consistent with qualitative evidence from a complementary performance evaluation and point to persistent constraints related to market access, commercialization support, and the intensity of nutrition-sensitive interventions in remote rural areas. More generally, the results highlight the challenges of generating measurable welfare and nutrition gains through integrated value chain interventions implemented in vulnerable rural settings. Related findings were observed, for example, for a

multidimensional agricultural value chain project in Liberia, where improvements in production and food access outcomes were not accompanied by measurable gains in child nutritional indicators (Rutherford et al., 2016).

The relatively modest impacts observed over the evaluation period do not necessarily imply that the interventions failed to benefit beneficiary households. The effects of comprehensive programs aimed at strengthening agricultural value chains and improving nutrition may take longer to materialize, particularly in settings characterized by liquidity constraints and weak commercialization channels. Cultural norms and dietary habits may also influence the adoption of nutrition-related practices and behavioral changes promoted by these interventions. Taken together, these findings suggest that integrating nutrition-sensitive components into agricultural value chain interventions may not be sufficient, by itself, to generate measurable improvements in longer-term child nutritional outcomes, especially in contexts characterized by persistent market, institutional, and environmental challenges, underscoring the importance of accounting for broader contextual factors in project design and evaluation. The results point to the need to complement agricultural value chain interventions with stronger market integration mechanisms, sustained nutrition-sensitive support, and context-specific strategies that address the structural constraints faced by vulnerable rural households. Ultimately, additional research is needed to better understand which combinations of agricultural, market-access, and nutrition-sensitive interventions are most effective in generating sustained welfare and nutritional improvements in resource-constrained settings, including through pilot and experimental approaches evaluating alternative intervention designs.

Finally, it is important to emphasize that the project was implemented during a period characterized by multiple overlapping shocks, particularly the COVID-19 pandemic. While the empirical strategy assumes that broad systemic shocks such as the pandemic affected beneficiary and control households similarly, these shocks may still have influenced households' day-to-day production, economic, financial, and intra-household decisions, potentially reducing households' capacity to adopt and implement some of the promoted agricultural and nutrition practices and attenuating some of the intended behavioral changes and project effects. Using part of the same study population in the Western Highlands of Guatemala, Castillo and Hernandez (2023) and Castillo and Hernandez (2025), for instance, document general changes in individual and social preferences following the COVID-19 pandemic, including shifts in risk attitudes and interpersonal trust. The overall results of the study should therefore be interpreted in light of this implementation context.

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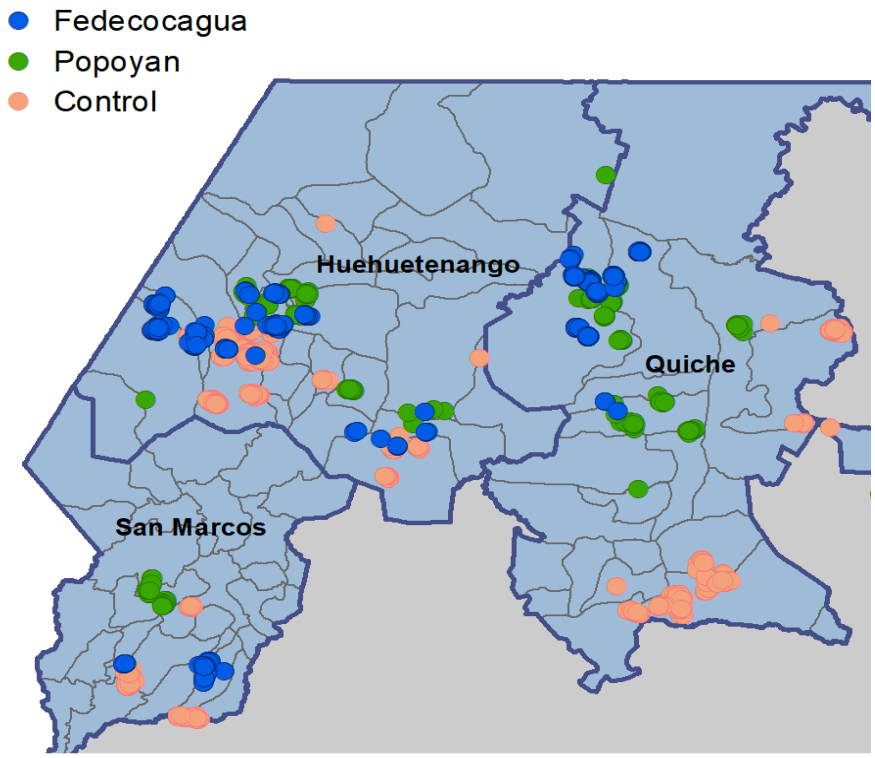
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Figure 1. Geographic distribution of study sample



Note: The map indicates the geographic location of the communities visited in 2019 and 2022. The location of each community was determined by calculating the average of the coordinates of all households interviewed within it.

Table 1. Baseline balance of household characteristics

	(1)	(2)	(3)
Variable	Beneficiary households	Control households	Diff.
Household head is male	0.843	0.848	-0.005
Household head age	49.780	47.450	2.337
Household head with incomplete elementary education	0.327	0.302	0.025
Household head with completed elementary education or above	0.268	0.303	-0.035
Household head main language spoken is Spanish	0.397	0.273	0.124
Average household size	5.954	6.142	-0.188
Dwelling with exterior finished walls	0.512	0.382	0.130
Dwelling with finished ceiling	0.161	0.095	0.066**
Dwelling with finishing flooring	0.602	0.471	0.131
Dwelling connected to electricity	0.832	0.771	0.061
Dwelling connected to water system	0.865	0.807	0.058
Dwelling connected to a drainage network	0.387	0.205	0.181**
Household uses electricity or gas for cooking	0.035	0.021	0.014
Household owns cellphone	0.923	0.887	0.036
Household owns TV or radio	0.720	0.710	0.011
Household owns any vehicle	0.295	0.159	0.136***
Household owns livestock	0.524	0.579	-0.054
Agricultural land size (in hectares)	1.285	0.762	0.523**
# observation	776	954	

Note: This table reports baseline balance statistics for household characteristics. Columns (1)-(3) report beneficiary means, control means, and differences between the two groups, respectively. The table is based on 1,730 households, including 776 beneficiary and 954 control households. Of these, 713 beneficiary and 749 control households were surveyed at both baseline (2019) and endline (2022) and constitute the panel sample used in the main analysis. An additional 63 beneficiary and 205 control households with at least one child under two years of age were surveyed only at baseline and are part of the sample used in the repeated cross-section specifications for child indicators. The statistical significance of the differences between beneficiary and control groups, reported in column (3), is based on regressions of each variable on a treatment indicator, estimated using linear models with robust standard errors clustered at the community level. Asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 2. Baseline summary statistics of outcome variables

	(1)	(2)	(3)	(4)
Outcome	Total households Mean	Total Observations	Beneficiary households Mean	Control households Mean
Number of crops produced	2.100	1,354	2.228	1.968
	(1.185)		(1.281)	(1.062)
Produces fruits & vegetables	0.173	1,354	0.176	0.170
	(0.378)		(0.381)	(0.376)
Produces grains & tubers	0.563	1,354	0.484	0.644
	(0.496)		(0.500)	(0.479)
Produces legumes	0.310	1,354	0.266	0.356
	(0.463)		(0.442)	(0.479)
Produces coffee	0.706	1,354	0.839	0.569
	(0.456)		(0.368)	(0.496)
Produces cardamom	0.195	1,354	0.240	0.149
	(0.396)		(0.427)	(0.356)
Share of main crop production sold (0-100)	74.340	1,321	80.770	67.640
	(38.860)		(33.830)	(42.480)
Daily per capita household expenditure, 2017 PPP US$	1.282	1,434	1.435	1.140
	(1.193)		(1.373)	(0.977)

(Cont.)

Table 2. Baseline summary statistics of outcome variables (Continuation)

	(1)	(2)	(3)	(4)
Outcome	Total households Mean	Total Observations	Beneficiary households Mean	Control households Mean
Household Dietary Diversity Score (HDDS), scale 0-12	6.705	1,432	6.966	6.452
	(1.910)		(1.936)	(1.850)
Household Animal Source Food (ASF) score, scale 0-7	1.295	1,432	1.402	1.191
	(1.008)		(1.076)	(0.927)
Household Fruits & Vegetables (F&V) score, scale 0-5	2.092	1,432	2.222	1.967
	(1.489)		(1.466)	(1.502)
Women Dietary Diversity Score (WDDS), scale 0-9	4.484	1,098	4.662	4.317
	(1.443)		(1.488)	(1.381)
Prevalence of moderate or severe food insecurity	0.396	1,452	0.388	0.404
	(0.489)		(0.488)	(0.491)
Height-for-age z score (HAZ) children under two years old	-1.796	679	-1.904	-1.731
	(1.831)		(1.554)	(1.979)
Weight-for-height z-score (WHZ) children under two years old	0.409	667	0.344	0.447
	(1.406)		(1.343)	(1.443)

Note: This table reports baseline summary statistics for the main outcome variables. Columns (1)-(4) report the full sample mean, number of observations, beneficiary mean, and control mean, respectively. Means are presented with standard deviations in parentheses. Household-level outcomes, including women's dietary diversity, are based on households surveyed in both 2019 and 2022. Height-for-age z-scores (HAZ) and weight-for-height z-scores (WHZ) are based on the repeated cross-section sample of children under two years old observed at baseline.

Table 3. Agricultural production and household expenditure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome	Number of crops produced	Produces fruits & vegetables	Produces grains & tubers	Produces legumes	Produces coffee	Produces cardamom	Share of main crop production sold (0-100)	Daily per capita household expenditure (2017 PPP US$)
Beneficiary household x 2022 year	0.103*	0.057***	0.038	0.014	-0.017	0.023**	6.057	0.054
	(0.054)	(0.017)	(0.025)	(0.016)	(0.013)	(0.010)	(6.118)	(0.116)
# observations	2,708	2,708	2,708	2,708	2,708	2,708	2,642	2,868
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	0.170	0.644	0.356	0.569	0.149	67.640	1.140

Note: This table reports differences-in-differences (DID) estimates for agricultural production indicators and daily per capita household expenditure using household panel data from 2019 and 2022. All specifications include household-level controls and household fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Household and women's dietary diversity and food insecurity

Coefficient	(1) Household Dietary Diversity Score (HDDS)	(2) Household Animal Source Food (ASF) score	(3) Household Fruits & Vegetables (F&V) score	(4) Women Dietary Diversity Score (WDDS)	(5) Prevalence of moderate or severe food insecurity
Beneficiary household x 2022 year	-0.073	-0.078	0.195	0.153	-0.125**
	(0.234)	(0.113)	(0.192)	(0.146)	(0.050)
# observations	2,864	2,864	2,864	2,196	2,904
Control variables	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	6.452	1.191	1.967	4.317	0.404

Note: This table reports differences-in-differences (DID) estimates for household and women's dietary diversity indicators and food insecurity using household panel data from 2019 and 2022. All specifications include household-level controls and household fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5. Child anthropometric outcomes

	(1)	(2)
Coefficient	Height-for-age z-score (HAZ)	Weight-for-height z-score (WHZ)
Beneficiary household x 2022 year	-0.013	0.470***
	(0.229)	(0.170)
# observations	1,167	1,159
Control variables	Yes	Yes
Community Fixed Effects	Yes	Yes
Mean outcome value at baseline (Control)	-1.731	0.447

Note: This table reports differences-in-differences (DID) estimates for anthropometric outcomes among children under two years old using repeated cross-section data from 2019 and 2022. All specifications include household-level controls and community fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6. Main outcomes by project implementing partner

Coefficient	(1) Number of crops produced	(2) Daily per capita household expenditure (2017 PPP US$)	(3) Household Dietary Diversity Score (HDDS)	(4) Prevalence of moderate or severe food insecurity	(5) Height-for-age z-score (HAZ)	(6) Weight-for-height z-score (WHZ)
Beneficiary household x 2022 year	0.197***	0.032	-0.131	-0.086	-0.087	0.515**
	(0.069)	(0.128)	(0.260)	(0.060)	(0.237)	(0.206)
Beneficiary household x 2022 year x Popoyan	-0.197**	0.045	0.123	-0.081	0.153	-0.096
	(0.077)	(0.166)	(0.313)	(0.053)	(0.235)	(0.220)
# observations	2,708	2,868	2,864	2,904	1,167	1,159
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Household/Community Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	1.140	6.452	0.404	-1.731	0.447

Note: This table reports differences-in-differences (DID) estimates for selected household and child outcomes by project implementing partner. Columns (1)-(4) are estimated using household panel data from 2019 and 2022 and include household fixed effects. Columns (5)-(6) are estimated using repeated cross-section data from 2019 and 2022 and include community fixed effects. All specifications include household-level controls. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7. Main outcomes by project component

Coefficients	(1) Number of crops produced	(2) Daily per capita household expenditure (2017 PPP US$)	(3) Household Dietary Diversity Score (HDDS)	(4) Prevalence of moderate or severe food insecurity	(5) Height-for-age z-score (HAZ)	(6) Weight-for-height z-score (WHZ)
Component 1 beneficiary x 2022 year	0.051	0.280*	0.029	-0.118**	0.059	0.344
	(0.071)	(0.145)	(0.245)	(0.055)	(0.303)	(0.298)
Component 2 beneficiary x 2022 year	0.020	-0.036	0.078	-0.015	0.173	0.120
	(0.089)	(0.152)	(0.195)	(0.050)	(0.283)	(0.209)
Component 3 beneficiary x 2022 year	0.027	-0.263*	-0.147	-0.009	0.030	0.022
	(0.073)	(0.156)	(0.196)	(0.039)	(0.297)	(0.296)
# observations	2,668	2,824	2,820	2,860	1,158	1,151
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	1.140	6.452	0.404	-1.731	0.447
Test of equality across treatments (lincom p-values)						
Component 1 = Component 2	0.802	0.203	0.891	0.280	0.816	0.575
Component 1 = Component 3	0.856	0.045	0.625	0.146	0.954	0.564
Component 2 = Component 3	0.962	0.346	0.435	0.912	0.761	0.804

Note: This table reports differences-in-differences (DID) estimates for selected household and child outcomes by project component: Agricultural productivity and income generation (Component 1), Market access (Component 2), and Food security and nutrition (Component 3). Columns (1)-(4) are estimated using household panel data from 2019 and 2022 and include household fixed effects. Columns (5)-(6) are estimated using repeated cross-section data from 2019 and 2022 and include community fixed effects. All specifications include household-level controls. Robust standard errors clustered at the community level are reported in parentheses. Reported p-values correspond to tests of equality across component-specific treatment effects. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 8. Main outcomes by intensity of treatment

Coefficient	(1) Number of crops produced	(2) Daily per capita household expenditure (2017 PPP US$)	(3) Household Dietary Diversity Score (HDDS)	(4) Prevalence of moderate or severe food insecurity	(5) Height-for-age z-score (HAZ)	(6) Weight-for-height z-score (WHZ)
Beneficiary household x 2022 year	0.063	0.170	-0.162	-0.115*	-0.339	0.814***
	(0.081)	(0.190)	(0.246)	(0.061)	(0.252)	(0.237)
Beneficiary household x 2022 year x More than one component	0.050	-0.145	0.112	-0.012	0.416*	-0.441**
	(0.082)	(0.170)	(0.188)	(0.050)	(0.216)	(0.178)
# observations	2,708	2,868	2,864	2,904	1,167	1,159
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Household/Community Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	1.140	6.452	0.404	-1.731	0.447

Note: This table reports differences-in-differences (DID) estimates for selected household and child outcomes by treatment intensity, distinguishing between beneficiary households receiving support under only one project component and those receiving support under multiple project components. Columns (1)-(4) are estimated using household panel data from 2019 and 2022 and include household fixed effects. Columns (5)-(6) are estimated using repeated cross-section data from 2019 and 2022 and include community fixed effects. All specifications include household-level controls. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 9. Main outcomes by exposure to shocks

	(1)	(2)
Coefficient	Tropical storms	Fertilizer price spike
	Panel A: Number of crops produced	
Beneficiary household x 2022 year	0.056	0.103*
	(0.060)	(0.056)
Beneficiary household x 2022 year x Shock exposure	0.096	0.003
	(0.066)	(0.059)
# observations	2,708	2,708
Mean outcome value at baseline (Control)	1.968	1.968
	Panel B: Daily per capita household expenditure (2017 PPP US$)	
Beneficiary household x 2022 year	0.033	-0.002
	(0.127)	(0.114)
Beneficiary household x 2022 year x Shock exposure	0.041	0.268
	(0.177)	(0.175)
# observations	2,868	2,868
Mean outcome value at baseline (Control)	1.140	1.140
	Panel C: Household Dietary Diversity Score (HDDS)	
Beneficiary household x 2022 year	-0.533**	-0.087
	(0.259)	(0.242)
Group indicator x 2022 survey round	0.917***	0.070
	(0.264)	(0.210)
# observations	2,864	2,864
Mean outcome value at baseline (Control)	6.452	6.452
	Panel D: Prevalence of moderate or severe food insecurity	
Beneficiary household x 2022 year	-0.119*	-0.139***
	(0.062)	(0.052)
Beneficiary household x 2022 year x Shock exposure	-0.010	0.069
	(0.053)	(0.057)
# observations	2,904	2,904
Mean outcome value at baseline (Control)	0.404	0.404

(Cont.)

Table 9. Main outcomes by exposure to shocks (Continuation)

	(1)	(2)
Coefficient	Tropical storms	Fertilizer price spike
	Panel E: Height-for-age z-score (HAZ)	
Beneficiary household x 2022 year	-0.224	-0.037
	(0.265)	(0.239)
Beneficiary Household x 2022 year x Shock exposure:	0.344	0.189
	(0.223)	(0.323)
# observations	1,167	1,167
Mean outcome value at baseline (Control)	-1.731	-1.731
	Panel F: Weight-for-height z-score (WHZ)	
Beneficiary household x 2022 year	0.339	0.490***
	(0.226)	(0.173)
Beneficiary household x 2022 year x Shock exposure	0.214	-0.154
	(0.226)	(0.279)
# observations	1,159	1,159
Mean outcome value at baseline (Control)	0.447	0.447
Control variables	Yes	Yes
Household/Community Fixed Effects	Yes	Yes

Note: This table reports differences-in-differences (DID) estimates for selected household and child outcomes by exposure to shocks. "Shock exposure" refers to household exposure to tropical storms or fertilizer price increases, depending on the specification. The tropical storm indicator is based on household reports in the endline survey that ETA, IOTA, or Julia affected crop production. The fertilizer shock indicator identifies households reporting substantial increases in fertilizer prices between baseline and endline (upper tercile of the distribution). Panels A-D are estimated using household panel data from 2019 and 2022 and include household fixed effects. Panels E-F are estimated using repeated cross-section data from 2019 and 2022 and include community fixed effects. All specifications include household-level controls. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Appendix

Figure A.1. Project main activities and interventions by implementing partner and component

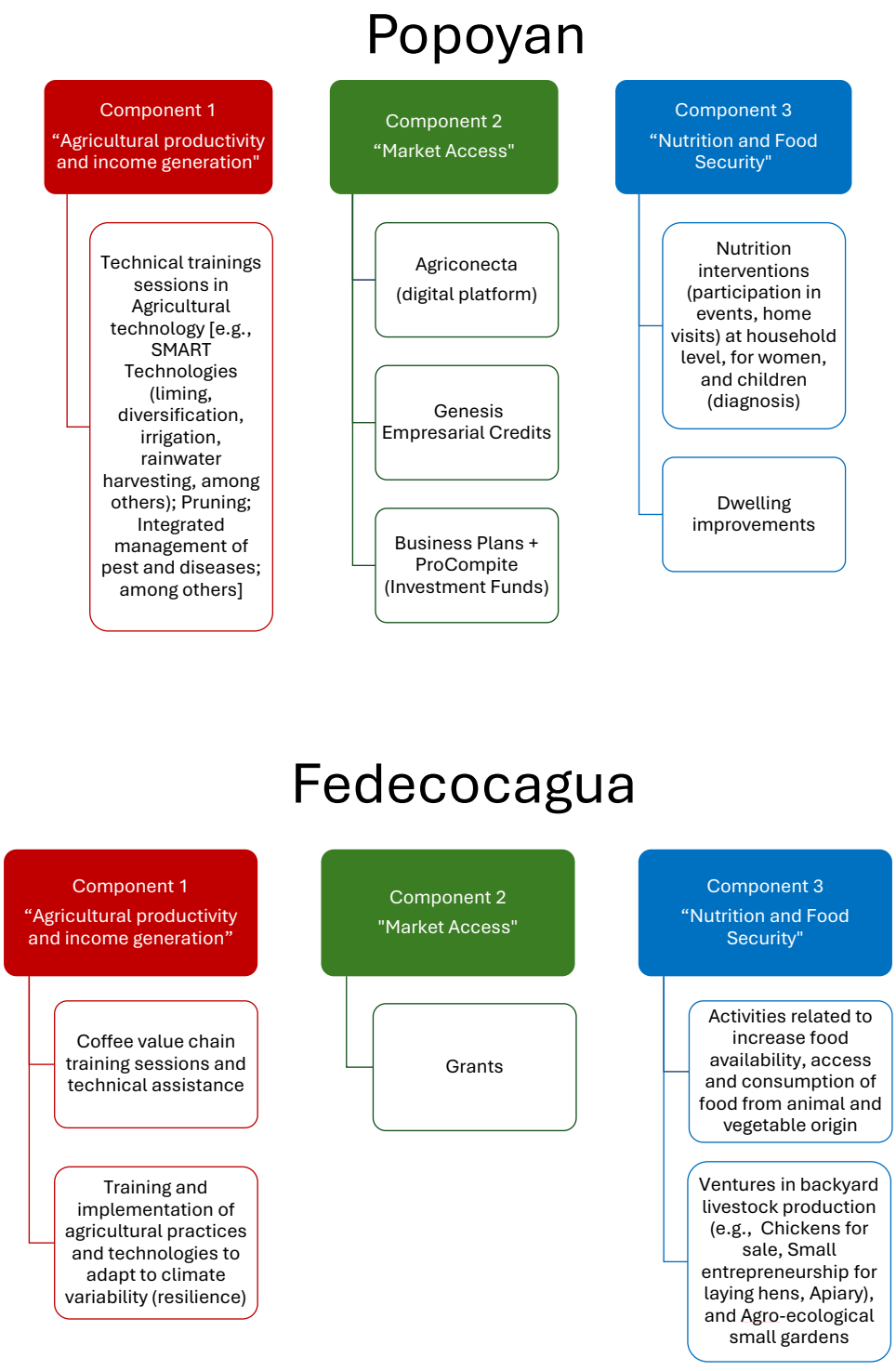
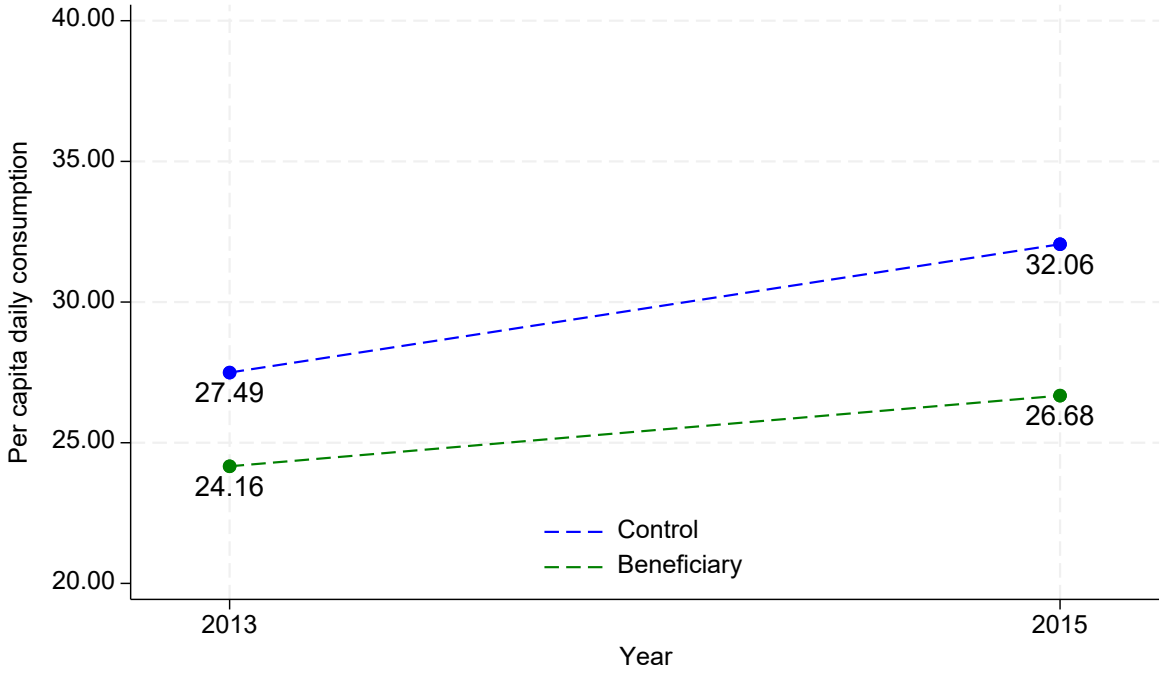
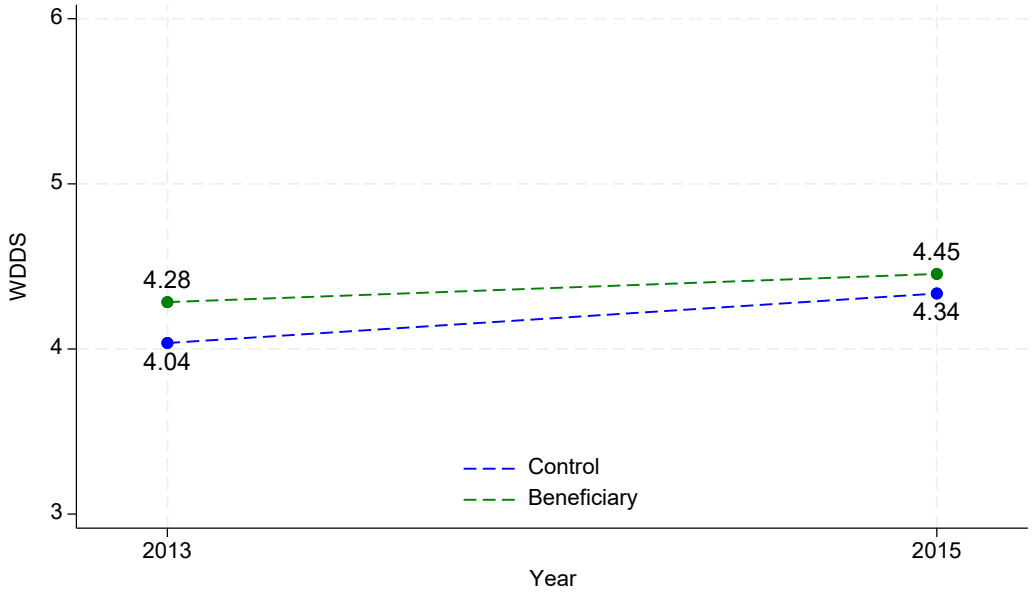


Figure A.2. Suggestive evidence on pre-treatment trends using auxiliary data

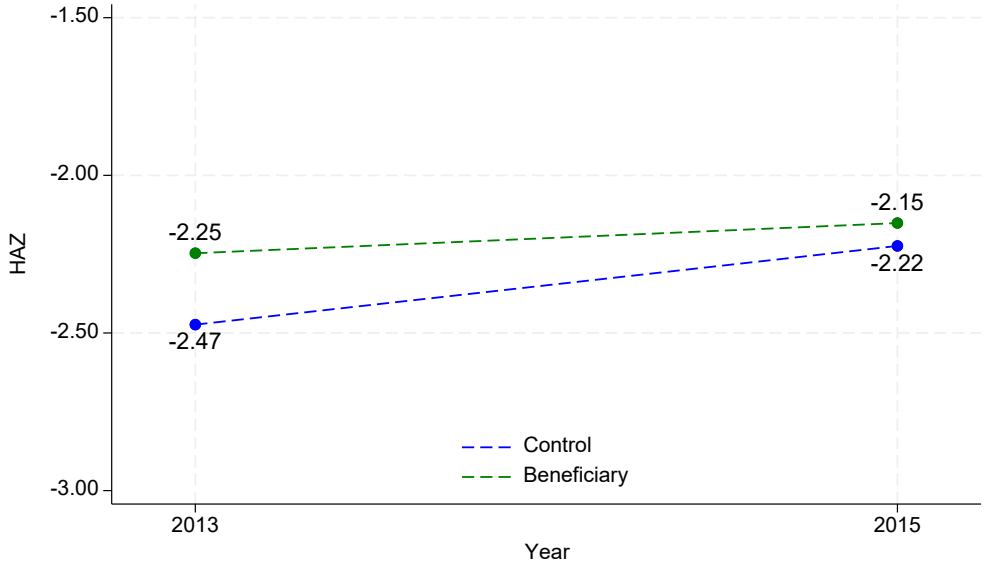
Panel A: Per capita daily consumption (Quetzales)



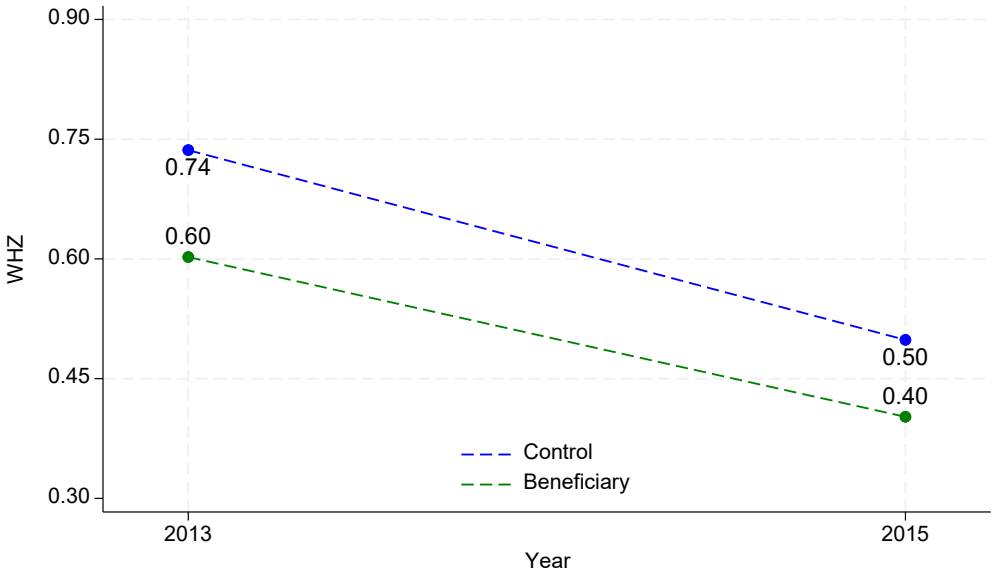
Panel B: Women's Dietary Diversity Score (WDDS)



Panel C: Height for age z-score (HAZ) for children under 2



Panel D: Weight for height z-score (WHZ) for children under 2



Note: The figure reports municipality-level averages of household survey outcomes for per capita daily consumption in Quetzales (Panel A), the Women's Dietary Diversity Score for women aged 15-45 (Panel B), the height-for-age z-score (HAZ) for children under two years old (Panel C), and the weight-for-height z-score (WHZ) for children under two years old (Panel D) for treated and control municipalities. Data are drawn from auxiliary sources collected during an earlier program in the area, the Western Highlands Integrated Program (WHIP), and are not necessarily directly comparable to the survey-based estimates used in the main analysis.

Table A.1. Baseline balance between baseline-only and panel communities

Characteristics in 2019	(1) Communities surveyed only in 2019	(2) Communities surveyed in the two survey rounds	(3) Difference
Household head is male	0.873	0.814	-0.059
Household head age	47.960	49.581	1.620
Household head did not complete elementary education	0.254	0.339	0.085
Household head completed elementary education or above	0.335	0.265	-0.070
Household head main language spoken is Spanish	0.228	0.422	0.194**
Household size	5.210	5.804	0.594*
Dwelling has finished walls	0.478	0.512	0.034
Dwelling has finished ceiling	0.140	0.158	0.018
Dwelling has finished floors	0.639	0.620	-0.019
Dwelling is connected to electricity	0.825	0.873	0.048
Dwelling is connected to water system	0.867	0.839	-0.028
Dwelling is connected to drainage network	0.367	0.363	-0.005
Cooking fuel of household is electricity or gas	0.079	0.040	-0.039
Household owns a cellphone	0.904	0.930	0.026
Household owns TV or radio	0.734	0.763	0.030
Household owns a vehicle	0.264	0.274	0.010
Household owns livestock	0.573	0.563	-0.010
Agricultural land size of household (in hectares)	1.311	0.995	-0.315
Observations	26	65	

Note: This table reports baseline balance statistics at the community level for communities surveyed only in 2019 and for communities surveyed in both 2019 and 2022. Columns (1)-(3) report means for baseline-only communities, means for panel communities, and differences between the two groups, respectively. Statistical significance for the differences reported in Column (3) is based on linear regressions of each variable on an indicator for whether the community was re-surveyed in 2022, estimated using heteroskedasticity-robust standard errors. Asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A.2. Baseline balance between baseline-only and panel households, by treatment status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Characteristics in 2019	Households surveyed only in 2019	Households surveyed in the two survey rounds	Difference	Control households surveyed only in 2019	Control households surveyed in both rounds	Beneficiary households surveyed only in 2019	Beneficiary households surveyed in both rounds	Difference in differences
Household head is male	0.831	0.841	0.010	0.835	0.840	0.819	0.842	0.018
Household head age	45.468	49.348	3.880***	44.971	48.372	46.762	50.373	0.210
Household head did not complete elementary education	0.274	0.323	0.049	0.283	0.315	0.252	0.331	0.047
Household head completed elementary education or above	0.382	0.268	-0.113***	0.377	0.284	0.394	0.251	-0.050
Household head main language spoken is Spanish	0.176	0.364	0.188***	0.135	0.318	0.284	0.412	-0.054
Household size	5.546	5.868	0.322**	5.656	5.916	5.259	5.818	0.299
Dwelling has finished walls	0.413	0.455	0.042	0.378	0.394	0.504	0.519	0.000
Dwelling has finished ceiling	0.128	0.133	0.006	0.109	0.104	0.177	0.164	-0.009
Dwelling has finished floors	0.448	0.558	0.110**	0.422	0.503	0.518	0.616	0.016
Dwelling is connected to electricity	0.769	0.811	0.042	0.766	0.778	0.777	0.844	0.055
Dwelling is connected to water system	0.832	0.840	0.008	0.814	0.814	0.879	0.867	-0.013
Dwelling is connected to drainage network	0.283	0.291	0.008	0.268	0.196	0.323	0.391	0.140
Cooking fuel of household is electricity or gas	0.034	0.026	-0.008	0.027	0.020	0.053	0.032	-0.014
Household owns a cellphone	0.895	0.900	0.005	0.878	0.877	0.940	0.924	-0.015
Household owns TV or radio	0.675	0.726	0.052	0.668	0.733	0.691	0.719	-0.037
Household owns a vehicle	0.178	0.241	0.063**	0.150	0.182	0.252	0.303	0.019
Household owns livestock	0.572	0.550	-0.022	0.597	0.563	0.507	0.536	0.063
Agricultural land size of household (in hectares)	0.908	1.018	0.110	0.831	0.749	1.109	1.300	0.272
Observations	1,017	1,462	2,479	735	749	282	713	

Note: This table reports baseline balance statistics at the household level for households surveyed only in 2019 and for households surveyed in both 2019 and 2022. Columns (1)-(3) report means for baseline-only households, means for panel households, and differences between the two groups, respectively. Columns (4)-(7) report the corresponding means separately for control and beneficiary households. Column (8) reports differences in attrition-related gaps between beneficiary and control households, estimated using the interaction between treatment status and an indicator for whether the household was re-surveyed in 2022. Statistical significance is based on linear regressions with standard errors clustered at the community level. Asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Joint tests reject the null that the 18 baseline characteristics are jointly unrelated to re-interview status ($F = 4.301$, $p < 0.001$), but not the null that their interactions with treatment status are jointly zero ($F = 1.140$, $p = 0.329$). Both tests use 2,479 households.

Table A.3. Baseline balance in outcome variables between baseline-only and panel households, by treatment status

Characteristics in 2019	(1) Households surveyed only in 2019	(2) Households surveyed in the two survey rounds	(3) Difference	(4) Control households surveyed only in 2019	(5) Control households surveyed in both rounds	(6) Beneficiary households surveyed only in 2019	(7) Beneficiary households surveyed in both rounds	(8) Difference in differences
Number of crops produced	1.828	2.070	0.242***	1.730	1.896	2.094	2.252	-0.008
Produces fruits & vegetables	0.085	0.190	0.105***	0.057	0.141	0.162	0.241	-0.005
Produces grains & tubers	0.526	0.521	-0.005	0.544	0.601	0.477	0.437	-0.098
Produces legumes	0.209	0.212	0.004	0.178	0.182	0.293	0.244	-0.055
Produces coffee	0.780	0.769	-0.011	0.782	0.660	0.774	0.884	0.232*
Produces cardamom	0.136	0.199	0.063	0.110	0.166	0.207	0.234	-0.030
Share of main crop production sold (0-100)	71.491	74.197	2.706	69.393	67.716	77.177	80.966	5.466
Daily per capita household expenditure, 2017 PPP US$	1.527	1.369	-0.158	1.375	1.167	1.924	1.582	-0.134
Household Dietary Diversity Score (HDDS), scale 0-12	6.706	6.702	-0.003	6.622	6.450	6.922	6.966	0.217
Household Animal Source Food (ASF) score, scale 0-7	1.171	1.295	0.124	1.112	1.194	1.324	1.400	-0.005
Household Fruits & Vegetables (F&V) score, scale 0-5	2.071	2.093	0.022	2.044	1.967	2.142	2.223	0.157
Women Dietary Diversity Score (WDDS), scale 0-9	4.410	4.504	0.094	4.356	4.345	4.565	4.674	0.121
Prevalence of moderate or severe food insecurity	0.358	0.398	0.040	0.373	0.404	0.318	0.392	0.043
Height-for-age z score (HAZ) children under two years old	-1.920	-1.707	0.213	-1.955	-1.495	-1.808	-1.939	-0.592
Weight-for-height z-score (WHZ) children under two years old	0.452	0.377	-0.074	0.516	0.378	0.264	0.376	0.250
Observations	1,017	1,462	2,479	735	749	282	713	

Note: This table reports baseline balance statistics for outcome variables for households surveyed only in 2019 and for households surveyed in both 2019 and 2022. Columns (1)-(3) report means for baseline-only households, means for panel households, and differences between the two groups, respectively. Columns (4)-(7) report the corresponding means separately for control and beneficiary households. Column (8) reports differences in attrition-related gaps between beneficiary and control households, estimated using the interaction between treatment status and an indicator for whether the household was re-surveyed in 2022. Statistical significance is based on linear regressions with standard errors clustered at the community level. Asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The number of nonmissing observations varies across outcomes; the observations reported in the last row correspond to the total baseline household sample in each group. HAZ and WHZ are calculated for children under two years of age. Joint tests reject the null that the 13 baseline household outcomes are jointly unrelated to re-interview status ($F = 3.494$, $p < 0.001$), but not the null that their interactions with treatment status are jointly zero ($F = 1.139$, $p = 0.338$). Both tests use 2,105 households and exclude the two child anthropometric outcomes.

Table A.4. Romano-Wolf adjusted p-values for baseline estimates

Outcomes	(1) Baseline p-values	(2) Romano–Wolf adjusted p-values
	Panel A. Household expenditure and agricultural production	
Number of crops produced	0.060	0.100
Produces fruits & vegetables	0.001	0.002
Produces grains & tubers	0.132	0.233
Produces legumes	0.403	0.496
Produces coffee	0.188	0.310
Produces cardamom	0.027	0.054
Share of main crop production sold (0-100)	0.324	0.434
Daily per capita household expenditure (2017 PPP US$)	0.644	0.539
	Panel B. Dietary diversity and food insecurity	
Household Dietary Diversity Score (HDDS)	0.756	0.596
Household Animal Source Food (ASF) score	0.490	0.413
Household Fruits & Vegetables (F&V) score	0.311	0.332
Women Dietary Diversity Score (WDDS)	0.300	0.332
Prevalence of moderate or severe food insecurity	0.015	0.002
	Panel C. Child nutritional outcomes	
Height-for-age z-score (HAZ)	0.955	0.919
Weight-for-height z-score (WHZ)	0.007	0.001

Note: This table reports Romano-Wolf (2005) adjusted p-values to account for multiple hypothesis testing across outcome families in the baseline estimates. Adjusted p-values are computed separately for agricultural production indicators and household expenditure in Panel A, dietary diversity and food insecurity indicators in Panel B, and child anthropometric outcomes in Panel C. Baseline p-values correspond to the main differences-in-differences (DID) estimates reported in Tables 3-5.

Table A.5. Agricultural production and household expenditure, alternative models

Coefficient	(1) Number of crops produced	(2) Produces fruits & vegetables	(3) Produces grains & tubers	(4) Produces legumes	(5) Produces coffee	(6) Produces cardamom	(7) Share of main crop production sold (0-100)	(8) Daily per capita household expenditure (2017 PPP US$)
	Panel A: DID with propensity score weighting							
Beneficiary household x 2022 year	0.101	0.065**	0.038	0.008	-0.028	0.026*	7.230	0.016
	(0.083)	(0.026)	(0.035)	(0.023)	(0.020)	(0.016)	(9.185)	(0.166)
# observations	2,708	2,708	2,708	2,708	2,708	2,708	2,642	2,868
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	0.170	0.644	0.356	0.569	0.149	67.640	1.140
	Panel B: DID with propensity score matching							
Beneficiary household x 2022 year	0.042	0.054*	0.029	-0.023	-0.025	0.027*	6.606	0.080
	(0.097)	(0.031)	(0.038)	(0.029)	(0.021)	(0.015)	(8.405)	(0.146)
# observations	2,752	2,752	2,752	2,752	2,752	2,752	2,696	2,764
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.949	0.159	0.630	0.630	0.562	0.167	70.95	1.313

Note: Panel A of the table reports differences-in-differences (DID) estimates with propensity score weighting, while Panel B reports DID estimates using a matched sample based on propensity score matching. Estimates are for agricultural production indicators and daily per capita household expenditure using household panel data from 2019 and 2022. All specifications include household-level controls and household fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A.6. Household and women's dietary diversity and food insecurity, alternative models

Coefficient	(1) Household Dietary Diversity Score (HDDS)	(2) Household Animal Source Food (ASF) score	(3) Household Fruits & Vegetables (F&V) score	(4) Women Dietary Diversity Score (WDDS)	(5) Prevalence of moderate or severe food insecurity
	Panel A: DID with propensity score weighting				
Beneficiary household x 2022 year	0.089	-0.010	0.248	0.150	-0.139**
	(0.335)	(0.165)	(0.271)	(0.220)	(0.067)
# observations	2,864	2,864	2,864	2,196	2,904
Control variables	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	6.452	1.191	1.967	4.317	0.404
	Panel B: DID with propensity score matching				
Beneficiary household x 2022 year	0.299	0.041	0.316	0.274	-0.145**
	(0.394)	(0.245)	(0.277)	(0.211)	(0.066)
# observations	2,816	2,816	2,816	2,116	2,816
Control variables	Yes	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	6.662	1.284	2.079	4.517	0.343

Note: Panel A of the table reports differences-in-differences (DID) estimates with propensity score weighting, while Panel B reports DID estimates using a matched sample based on propensity score matching. Estimates are for household and women's dietary diversity indicators and food insecurity using household panel data from 2019 and 2022. All specifications include household-level controls and household fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A.7. Agricultural production and household expenditure, unbalanced household panel sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Coefficient	Number of crops produced	Produces fruits & vegetables	Produces grains & tubers	Produces legumes	Produces coffee	Produces cardamom	Share of main crop production sold (0-100)	Daily per capita household expenditure (2017 PPP US$)
Beneficiary household x 2022 year	0.105	0.063***	0.027	0.017	-0.016	0.014	6.255	0.054
	(0.068)	(0.018)	(0.031)	(0.022)	(0.016)	(0.010)	(5.822)	(0.127)
# observations	3,107	3,107	3,107	3,107	3,107	3,107	3,403	4,340
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	1.968	0.170	0.644	0.356	0.569	0.149	69.140	1.223

Note: This table reports differences-in-differences (DID) estimates for agricultural production indicators and daily per capita household expenditure using the unbalanced household panel sample from 2019 and 2022. All specifications include household-level controls and community fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A.8. Household and women's dietary diversity and food insecurity, unbalanced household panel sample

Coefficient	(1) Household Dietary Diversity Score (HDDS)	(2) Household Animal Source Food (ASF) score	(3) Household Fruits & Vegetables (F&V) score	(4) Women Dietary Diversity Score (WDDS)	(5) Prevalence of moderate or severe food insecurity
Beneficiary household x 2022 year	-0.067	-0.068	0.286	0.187	-0.132***
	(0.237)	(0.090)	(0.200)	(0.149)	(0.045)
# observations	4,387	4,387	4,387	2,196	4,411
Control variables	Yes	Yes	Yes	Yes	Yes
Community Fixed Effects	Yes	Yes	Yes	Yes	Yes
Mean outcome value at baseline (Control)	6.536	1.153	2.005	4.317	0.388

Note: This table reports differences-in-differences (DID) estimates for household and women's dietary diversity indicators and food insecurity using the unbalanced household panel sample from 2019 and 2022. All specifications include household-level controls and community fixed effects. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A.9. Main outcomes by household characteristics

Coefficient	(1)	(2)	(3)	(4)	(5)	(6)
	Male-headed household	Household head age	Household head education	Household size	Landholding size	San Marcos department
	Panel A: Number of crops produced					
Beneficiary household x 2022 year	0.052	0.175***	0.106*	0.099	0.111	0.074
	(0.074)	(0.062)	(0.057)	(0.069)	(0.069)	(0.058)
Beneficiary household x 2022 year x Group indicator	0.060	-0.121**	-0.010	0.009	-0.010	0.179**
	(0.069)	(0.056)	(0.067)	(0.094)	(0.068)	(0.078)
# observations	2,708	2,708	2,708	2,708	2,708	2,708
Mean outcome value at baseline (Control)	1.968	1.968	1.968	1.968	1.968	1.968
	Panel B: Daily per capita household expenditure (2017 PPP US$)					
Beneficiary household x 2022 year	0.035	0.030	0.068	0.112	0.002	0.055
	(0.232)	(0.137)	(0.115)	(0.149)	(0.138)	(0.126)
Beneficiary household x 2022 year x Group indicator	0.023	0.040	-0.063	-0.114	0.070	-0.006
	(0.264)	(0.117)	(0.170)	(0.132)	(0.127)	(0.165)
# observations	2,868	2,868	2,868	2,868	2,868	2,868
Mean outcome value at baseline (Control)	1.140	1.140	1.140	1.140	1.140	1.140

(Cont.)

Table A.9. Main outcomes by household characteristics (Continuation)

Coefficient	(1)	(2)	(3)	(4)	(5)	(6)
	Male-headed household	Household head age	Household head education	Household size	Landholding size	San Marcos department
	Panel C: Household Dietary Diversity Score (HDDS)					
Beneficiary household x 2022 year	-0.516	0.038	-0.065	-0.318	-0.156	0.152
	(0.322)	(0.252)	(0.231)	(0.245)	(0.250)	(0.231)
Beneficiary household x 2022 year x Group indicator	0.524**	-0.189	-0.033	0.499**	0.114	-1.359***
	(0.240)	(0.192)	(0.186)	(0.208)	(0.200)	(0.249)
# observations	2,864	2,864	2,864	2,864	2,864	2,864
Mean outcome value at baseline (Control)	6.452	6.452	6.452	6.452	6.452	6.452
	Panel D: Prevalence of moderate or severe food insecurity					
Beneficiary household x 2022 year	-0.167*	-0.133**	-0.145***	-0.079	-0.193***	-0.146***
	(0.085)	(0.062)	(0.053)	(0.055)	(0.067)	(0.053)
Beneficiary household x 2022 year x Group indicator	0.050	0.014	0.083	-0.093**	0.093	0.125*
	(0.069)	(0.056)	(0.058)	(0.038)	(0.062)	(0.071)
# observations	2,904	2,904	2,904	2,904	2,904	2,904
Mean outcome value at baseline (Control)	0.404	0.404	0.404	0.404	0.404	0.404

(Cont.)

Table A.9. Main outcomes by household characteristics (Continuation)

Coefficient	(1) Male-headed household	(2) Household head age	(3) Household head education	(4) Household size	(5) Landholding size	(6) San Marcos department
	Panel E: Height-for-age z-score (HAZ)					
Beneficiary household x 2022 year	-0.006	0.048	0.064	-0.057	0.010	0.075
	(0.278)	(0.242)	(0.231)	(0.248)	(0.255)	(0.223)
Beneficiary household x 2022 year x Group indicator	-0.009	-0.177	-0.346	0.117	-0.042	-1.038***
	(0.189)	(0.159)	(0.246)	(0.191)	(0.193)	(0.220)
# observations	1,167	1,167	1,167	1,167	1,167	1,167
Mean outcome value at baseline (Control)	-1.731	-1.731	-1.731	-1.731	-1.731	-1.731
	Panel F: Weight-for-height z-score (WHZ)					
Beneficiary household x 2022 year	0.542**	0.541***	0.364**	0.591***	0.592**	0.481***
	(0.258)	(0.169)	(0.178)	(0.202)	(0.228)	(0.168)
Beneficiary household x 2022 year x Group indicator	-0.101	-0.210	0.491**	-0.326*	-0.220	-0.133
	(0.228)	(0.169)	(0.234)	(0.180)	(0.231)	(0.565)
# observations	1,159	1,159	1,159	1,159	1,159	1,159
Mean outcome value at baseline (Control)	0.447	0.447	0.447	0.447	0.447	0.447
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Household/Community Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports differences-in-differences (DID) estimates for selected household and child outcomes by household characteristics. Group indicators correspond to male-headed households, household head age above the sample median, completion of primary education or above by the household head, household size above the sample median, agricultural landholding size above the sample median, and households located in the department of San Marcos. Panels A-D are estimated using household panel data from 2019 and 2022 and include household fixed effects. Panels E-F are estimated using repeated cross-section data from 2019 and 2022 and include community fixed effects. All specifications include household-level controls. Robust standard errors clustered at the community level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

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IFPRI HEADQUARTERS
1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org