

CAF - WORKING PAPER #2026/01

First version: December 18, 2025 (current)

Improving food security through community participation: results from a randomized field experiment in rural Nicaragua

Pablo A. Celhay¹

¹Escuela de Gobierno and Instituto de Economía, Pontificia Universidad Católica de Chile. pacelhay@uc.cl

This paper evaluates a community based development program designed to promote climate-smart agriculture and improve food security in rural Nicaragua. Using a within-community randomized controlled trial, we estimate short- and medium-term impacts on agricultural practices, production, and welfare. The program combined productive asset transfers, technical assistance, and training delivered through local solidarity groups. Results show significant increases in the adoption of improved inputs—such as certified seeds, bio-fertilizers, and post-harvest technologies—along with higher maize and bean yields, greater crop diversification, and expanded participation in producer organizations. Beneficiaries also report better food security and higher satisfaction with their quality of life. Because randomization occurred within communities, spillovers likely make these estimates conservative. The findings suggest that community-based delivery can effectively scale up CSA practices and strengthen food security in vulnerable rural areas.

KEYWORDS

Community Development Programs; Food Security; Agricultural Production; Impact Evaluation.

Small sections of text that are less than two paragraphs may be quoted without explicit permission as long as this document is acknowledged. Findings, interpretations and conclusions expressed in this publication are the sole responsibility of its author(s) and cannot be, in any way, attributed to CAF, its Executive Directors or the countries they represent. CAF does not guarantee the accuracy of the data included in this publication and is not, in any way, responsible for any consequences resulting from its use.

CAF - DOCUMENTO DE TRABAJO #2026/01

Esta versión: 18 de diciembre de 2025

Mejorando la seguridad alimentaria mediante la participación comunitaria: resultados de un experimento de campo aleatorizado en zonas rurales de Nicaragua

Pablo A. Celhay¹

¹Escuela de Gobierno and Instituto de Economía, Pontificia Universidad Católica de Chile. pacelhay@uc.cl

Este estudio evalúa un programa de desarrollo basado en la comunidad orientado a promover la agricultura climáticamente inteligente y mejorar la seguridad alimentaria en zonas rurales de Nicaragua. A partir de un experimento aleatorio dentro de comunidades, estimamos los efectos de corto y mediano plazo sobre las prácticas agrícolas, la producción y el bienestar. El programa combinó transferencias en especie, asistencia técnica y capacitación impartidas a través de grupos solidarios locales. Los resultados muestran aumentos significativos en la adopción de insumos mejorados —como semillas certificadas, biofertilizantes y tecnologías de poscosecha—, mayores rendimientos de maíz y frijol, mayor diversificación de cultivos y una participación ampliada en organizaciones productivas. Los beneficiarios también reportan mejoras en seguridad alimentaria y calidad de vida. Los hallazgos sugieren que los modelos comunitarios pueden escalar eficazmente la CSA y fortalecer la resiliencia rural.

KEYWORDS

Cooperativas, desarrollo local, crecimiento inclusivo, políticas basadas en el territorio.

Pequeñas secciones del texto, menores a dos párrafos, pueden ser citadas sin autorización explícita siempre que se cite el presente documento. Los resultados, interpretaciones y conclusiones expresados en esta publicación son de exclusiva responsabilidad de su(s) autor(es), y de ninguna manera pueden ser atribuidos a CAF, a los miembros de su Directorio Ejecutivo o a los países que ellos representan. CAF no garantiza la exactitud de los datos incluidos en esta publicación y no se hace responsable en ningún aspecto de las consecuencias que resulten de su utilización.

1 | INTRODUCTION

Community-based development (CBD) emphasize the role of local participation in the design and implementation of development programs.¹ These approaches seek to leverage local knowledge, increase community ownership, and improve the targeting and sustainability of development interventions (Mansuri and Rao, 2004, 2012). While the promise of CBD has spurred widespread adoption—especially in rural, fragile, or low-capacity settings—their effectiveness remains a subject of ongoing debate.

Community-based development (CBD) programs have shown promise in improving agricultural livelihoods by using local knowledge and better targeting poor and marginalized groups (Nkonya et al., 2012; Park and Wang, 2010). However, evidence across countries remains mixed. While some interventions improve participation and service delivery (Beath et al., 2017; Madajewicz et al., 2021), others find limited or no effects on income or governance outcomes (Humphreys et al., 2019; Saguin, 2018). Overall, the literature suggests that CBD effectiveness depends on strong institutional design, continuous support services, and safeguards against local elite capture.²

This paper studies the short- and medium-term effects of a community-based development (CBD) program that promoted climate-smart agricultural (CSA) practices in rural Nicaragua. The analysis relies on a randomized controlled trial implemented in 64 rural communities, where productive assets and CSA training were provided to randomly selected small farmers within each village. The program aimed to increase the adoption of sustainable farming practices, raise agricultural yields, and improve household food security through a participatory delivery model.

Raising crop yields is essential for sustainable growth in low-income countries, where many households depend on agriculture for their livelihoods (Antón et al., 2013). Climate-smart agriculture (CSA) has emerged as a key strategy to address the dual challenges of climate adaptation and food insecurity. Defined by the FAO as an approach to make agri-food systems more climate-resilient,³ CSA includes practices such as conservation agriculture, improved seeds, and agroforestry (Lipper et al., 2014; Jayne et al., 2018). Although CSA has been incorporated into many national policy agendas (Campbell et al., 2016), adoption among smallholders remains low because of high upfront costs, uncertain returns, and short-term risks to yield and consumption (Amadu et al., 2020; Arslan et al., 2015; Knowler and Bradshaw, 2007). Stronger evidence is needed on delivery models that can effectively promote CSA adoption and measure its impacts on productivity, food surplus, and household food security (Steenwerth et al., 2014; Battisti and Naylor, 2009).

We use data from the *Proyecto Apoyo para el Incremento de la Productividad, Seguridad Alimentaria y Nutricional en la Costa Caribe Nicaraguense* (PAIPSAN), a program designed to reduce food insecurity among rural communities in this region. To achieve this goal, the program encouraged beneficiaries to form cooperative groups known as solidarity groups. These groups served two main purposes: first, to identify the needs of each participant and prepare an Innovative Development Plan (Plan de Desarrollo Innovador,

¹Community-based development (CBD) – often termed community-driven development (CDD) – refers to aid strategies that delegate decision-making and resource allocation to local communities. See Bank (2025).

²Studies that explore the effects of CBD projects include, for instance, Alatas et al. (2012, 2019); Araujo et al. (2008); Avdeenko and Gilligan (2015); Beath et al. (2017); Bernard et al. (2008); Borisova et al. (2024); Casey et al. (2012); Casey (2018); Cooke and Kothari (2001); Dasgupta and Beard (2007); Heß et al. (2021); Humphreys et al. (2019); Kahsay and Bulte (2021); Krishna et al. (2025); Labonne and Chase (2011); Lund and Saito-Jensen (2013); Madajewicz et al. (2021); McNamara et al. (2020); Nguyen and Rieger (2017); Nkonya et al. (2012); Olken (2010); Park and Wang (2010); Platteau (2004); Pradhan et al. (2014); Saguin (2018); Salinger et al. (2024); Stiglitz (2002); White et al. (2018); Wong and Guggenheim (2018).

³See <https://www.fao.org/climate-smart-agriculture/en/>.

PDI) that guided the intervention; and second, to facilitate implementation by organizing the purchase and distribution of inputs, as well as workshops, demonstrations, and consultation meetings. This group-based structure represents the community component of the PAIPSAN program, reflecting its community-driven development (CDD) approach, where planning and implementation decisions were made collectively with each community rather than at a centralized level.

The intervention provided in-kind agricultural inputs—such as seeds, tools, and fertilizers—alongside technical assistance and training. Our analysis combines administrative and survey data to evaluate the program’s effects on smallholder farmers’ livelihoods. In particular, we study changes in training participation, livestock ownership, and involvement in productive organizations, and we assess how these interventions affected food security, perceived quality of life, and overall satisfaction among participants.

Households within each of the participating communities were randomly assigned to two groups: 908 participants in the treatment group, who began the project in June 2017, and 903 participants in the control group, who started in November 2018. Because the assignment was random, both groups were similar in their baseline characteristics, ensuring that any later differences can be attributed to the PAIPSAN-CCN intervention rather than pre-existing factors.

Data were collected from both groups between March 2017 and December 2018 through three survey rounds: a baseline survey (March–May 2017), a midline follow-up (March 2018), and a final survey (November 2018). The surveys covered 1,811 households—representing 8,583 individuals—across the 64 communities in the project area.

Our results show that the PAIPSAN-CCN intervention had a positive impact on the adoption of improved agricultural inputs among beneficiary households. Survey data indicate significant increases in the use of certified and fortified seeds, bio-fertilizers, pest control measures, and post-harvest practices. Treated farmers reported planting about 20 percent more basic grains than the control group, reflecting broader progress in the adoption of techniques promoted by the program.

The program also strengthened nutrition-sensitive practices, particularly in hygiene and food preparation. Beneficiaries in the treatment group reported performing more food preparation and preservation activities, using safer handling practices, and adopting natural ingredients and water filters more often. These behavioral changes were accompanied by higher rates of staple crop production: maize cultivation rose from 55 to 65 percent and bean cultivation from 68 to 84 percent among treated households.

In terms of production, treated farmers achieved higher yields across key crops. Maize yields increased from 9.7 to 15 quintals per manzana, while bean yields rose from 12 to 16.7 quintals over the same period. Similar gains were observed for other products, and the share of farmers producing fruit or perennial crops grew from 1 to 9 percent by late 2018. These results translated into higher satisfaction with harvests, quality of life, and household food security, as measured by the Food Insecurity Experience Scale (FIES). However, given the relatively short exposure period, it is too early to assess lasting effects on health or nutritional outcomes.

Our results contribute to the literature on community-based development (CBD) in two distinct ways. First, a central concern in this literature is that elite capture and local political dynamics can bias program impacts, making it hard to separate program design from local power relations (Platteau, 2004; Alatas et al., 2019). The within-community randomized design of our study helps address this issue by isolating treatment assignment from local political influence. This approach minimizes the scope for capture and provides a clean estimate of CBD effects on agricultural outcomes such as yields, technology adoption, and food security (Beath et al., 2017; Madajewicz et al., 2021; Humphreys et al., 2019).

Second, unlike previous studies that focus on improving participation in decision-making, committee transparency, or trust in local authorities, our analysis evaluates a CBD intervention centered on economic outcomes—specifically agricultural production and participants' welfare (Beath et al., 2017; Humphreys et al., 2019). In doing so, it contributes to the debate on whether community control can enhance service delivery and livelihoods when elite dominance is limited (Madajewicz et al., 2021). The result is a rigorous and internally valid estimate of CBD effectiveness in rural production settings, separate from the confounding effects of local political selection.

In addition, we provide rare experimental evidence from Latin America on how CSA can be integrated into a CBD model. The intervention aimed to reduce coordination, information, and risk barriers that often limit smallholders from adopting productive technologies. While most rigorous studies on agricultural community programs come from Africa and Asia—and often find short-lived or mixed results without complementary support (Nkonya et al., 2012; Park and Wang, 2010)—our study measures multi-season effects on crop yields, food insecurity, and adoption of improved inputs within villages. By combining in-kind assets, technical assistance, and collective implementation, the program tests key CSA mechanisms such as local learning, risk-sharing, and coordination at the community level (Lipper et al., 2014; Campbell et al., 2016). In this way, the paper helps explain why some CBD projects improve participation but not welfare (Beath et al., 2017; Humphreys et al., 2019; Saguin, 2018), identifying design features—household randomization, community platforms, and bundled support—that can make participatory delivery more effective in improving rural livelihoods.

2 | CONTEXT

We study the effects of climate-smart agriculture promoted by the *Proyecto de Apoyo para el Incremento de la Productividad, Seguridad Alimentaria y Nutricional en la Costa Caribe Nicaragüense* (PAIPSAN), coordinated by the *Ministerio de Economía Familiar, Comunitaria, Cooperativa y Asociativa* (MEFCCA). The main goal of the program was to improve food and nutritional security in rural communities on Nicaragua's Caribbean Coast, which includes two autonomous regions—the Northern (*Región Autónoma de la Costa Caribe Norte*, RACCN) and the Southern (*Región Autónoma de la Costa Caribe Sur*, RACCS). The project operated in 246 communities across 15 municipalities: eight in the north (Waslala, Bonanza, Siuna, Rosita, Mulukukú, Waspam, Prinzapolka, and Puerto Cabezas) and seven in the south (La Cruz de Río Grande, Paiwas, El Tortuguero, Desembocadura de Río Grande, Laguna de Perlas, Kukra Hill, and Bluefields).

The coordination and implementation of PAIPSAN-CCN are the responsibility of the Ministry of Family, Community, Cooperative, and Associative Economy (MEFCCA) and are carried out with financial support from a grant provided by the Global Agriculture and Food Security Program (GAFSP).

This area covers around 43% of the national territory (see Figure A.1) and was prioritized due to its high rates of poverty, malnutrition, and indigenous population. In 2012, 23.3% of children under five in the Northern region were stunted—6 percentage points above the national average—and, in 2014, the poverty rate was 9.4 percentage points higher than the national average of 29.6%. Approximately 35% of the population identified as indigenous (INIDE, 2016), mostly from the *Miskito* ethnic group, which represents over half of Nicaragua's indigenous population.

Beneficiaries were selected through community meetings with local authorities, based on poverty status and primary occupation. A key feature of the program was its participatory

structure: households organized themselves into *solidarity groups* of 30–50 members. These groups identified local needs, prepared *Planes de Desarrollo Innovador* (PDIs), and participated in the planning and implementation of the activities financed by the program.

Each PDI combined three main components:

1. **Financial support**, provided in kind—such as seeds, tools, fertilizers, machinery, or livestock.
2. **Technical assistance**, delivered by ministry field officers who demonstrated farming techniques, supported orchard setup, and followed up on each group’s progress.
3. **Training**, offered through workshops on topics such as crop diversification, fertilizer use, irrigation, storage, marketing, livestock care, food hygiene, and healthy diets. Training also included sessions on cooperative management and associative organization.

Solidarity groups facilitated coordination with the ministry, helped distribute inputs, and organized local activities. They functioned similarly to cooperatives—sharing responsibilities, solving problems collectively, and promoting the program within their communities. Participation brought clear benefits through access to inputs and knowledge but also required time, organization, and sustained community engagement.

In the survey, the term “community organizations” refers broadly to local economic and community groups linked to the implementation of the PDIs, such as producer associations, production committees, or work groups created under the project to coordinate purchases, sales, or training activities. These organizations were either created or strengthened as part of the intervention. Solidarity Groups are one specific organizational form used by the project to structure beneficiary participation within a PDI. Thus, the community-organization outcomes in Section 5.4 capture a wider set of associative arrangements than Solidarity Groups alone and reflect the broader institutional environment fostered by the program.

2.1 | Formation and Role of the *Planes de Desarrollo Innovador* (PDIs)

Within PAIPSAN–CCN, the *Planes de Desarrollo Innovador* (PDIs) are the core instrument that structures how resources are allocated and how the intervention is implemented on the ground. PDIs are not spontaneous proposals. They are formulated through a structured process facilitated by the Ministry of Family, Community, Cooperative and Associative Economy (MEFCCA), in coordination with institutions in the National System for Production, Consumption and Commerce (SNPCC). The process begins with a joint diagnostic of local productive potential, food insecurity, and market opportunities conducted by technical facilitators together with beneficiary households. Based on this assessment, each PDI defines a package of investments and services consistent with the project’s objective of improving food security and nutrition in the Caribbean Coast.

PDIs are organized into four broad types: family agriculture, agroindustry, artisanal fishing, and rural non-agricultural enterprises, reflecting the main livelihood strategies in the region. Within family agriculture and fishing, PDIs are further differentiated by orientation (subsistence/autoconsumption versus surplus/commercial production). This typology responds primarily to productive criteria (type of activity and market orientation), but PDIs are also shaped by territorial conditions such as access to water, infrastructure, and markets. Beneficiaries are not required to meet minimum technical or managerial criteria to design a PDI. Instead, the project embeds capacity building in the planning cycle: MEFCCA facilitators support the formulation, costing, and sequencing of activities and ensure that each PDI respects predefined budget ceilings, eligible expenditure categories, and technical

norms.

Functionally, PDIs operate as the main coordination device between beneficiary households and implementing agencies. Each PDI specifies (i) the mix of productive assets to be financed (for example, seeds, tools, small equipment), (ii) the schedule and content of trainings and technical assistance (including climate-smart agriculture, post-harvest management, and nutrition-sensitive practices), and (iii) the services to be provided by specialized public entities. In practice, INTA, MINSA, IPSA, MARENA, SERENA, and INPESCA⁴ are responsible for different components of the intervention: INTA for agricultural technologies and field schools; MINSA for nutrition education; IPSA for phytosanitary surveillance; MARENA and SERENA for environmental safeguards; and INPESCA for fishing and aquaculture, all coordinated by MEFCCA's project unit. In this way, PDIs concentrate local autonomy in setting priorities and choosing the combination of activities, while execution and compliance are anchored in a clear institutional framework.

From the perspective of the CBD literature, this institutional design matters for two reasons. First, local participation is exercised through a structured planning instrument (the PDI) supported by continuous technical assistance, rather than through ad hoc community demands. Second, standardized eligibility rules, investment ceilings, and multi-agency review introduce procedural safeguards that limit arbitrary allocation or capture, while still allowing plans to be tailored to local needs. Our impact estimates should therefore be interpreted as the effects of a community-based planning and delivery model in which PDIs embody the main institutional innovation.

3 | DATA AND STUDY SAMPLE

For the impact evaluation, a random sample of beneficiaries was drawn from the population. The sample size required to detect an impact was estimated to be 1,900 individuals, drawn from a total population of 14,000 people. Randomization was conducted at two levels: community and individual. Out of a total of 256 villages, 64 were selected to participate in the impact evaluation. Subsequent to this selection, program officials held assemblies in each village to assign individuals to treatment and control groups through a public lottery. Treatment assignment was phased in, meaning that both groups were provided the opportunity to participate in the program. The program commenced for the treatment group in June 2017, while it began for the control group in June 2018.

As illustrated in [Figure A.2](#), baseline data were collected during April and May of 2017. Although the estimated sample size was 1,900, due to challenges in the implementation of the baseline survey, the total number of households interviewed was 1,810, with 905 belonging to the treatment group and 905 to the control group. Two follow-up surveys were subsequently conducted: the first approximately one year after the baseline, and the second between December 2018 and March 2019. The attrition rate in these follow-ups was minimal; of the 1,810 families included in the baseline survey, 1,804 were interviewed in the first follow-up, and 1,802 in the second.

Descriptive characteristics.— For the data analysis, the sample was restricted to non-missing values of the variables across the three surveys, resulting in a total of 1,672 observations from an initial 1,810. [Table B.1](#) presents the mean and standard deviation of the demographic characteristics of the individuals and the outcome variables at baseline. A significant proportion of recipients are illiterate, nearly 30%, with a median age of approximately 39

⁴INTA: Instituto Nicaragüense de Tecnología Agropecuaria; MINSA: Ministerio de Salud; IPSA: Instituto de Protección y Sanidad Agropecuaria; MARENA: Ministerio del Ambiente y los Recursos Naturales; SERENA: Secretaría de Recursos Naturales de los gobiernos regionales; INPESCA: Instituto Nicaragüense de la Pesca y Acuicultura.

years. Additionally, around 25% of respondents identify as belonging to an indigenous group. The gender distribution in the sample is nearly balanced, with women slightly outnumbering men, comprising 51.26% of the observations. Certain dwelling characteristics highlight the poverty conditions of the beneficiaries: 50% of individuals live in homes with dirt floors, and only 53.67% have electricity. Furthermore, the majority of houses (90%) are constructed with wooden walls. The primary occupations of program recipients are agriculture and cattle raising; 95.6% report agriculture as their primary activity, and 79.55% engage in cattle raising, while only a small percentage (0.6%) is involved in forestry. Additionally, production decisions vary by season, with 71.83% of individuals participating in the sowing of any crop during the apante season, which is the most important growing season for this region, and 37.32% during the postrera season.

As in any RCT, a fundamental condition for estimating the impact of the PAIPSAN project is that the beneficiaries in the treatment group are statistically identical to those in the control group. This implies that, on average, the characteristics of the control group and the treatment group are equal. Table B.1 shows the results for a series of demographic indicators and project outcomes. These show the simple comparison of means between treatment protagonists and control group protagonists. The p-values (*p-value*) are calculated after adjusting the differences for sample stratification by estimating equation (1). In summary, the results show that the random assignment worked appropriately as there are no significant differences between the treatment group and the control group.

Table B.2 examines whether attrition is systematically related to treatment status or baseline household characteristics. The dependent variable is an indicator for remaining in the longitudinal sample, and all specifications include community fixed effects. The estimates show that the treatment indicator is small and statistically insignificant in all columns, indicating that treated and control households are equally likely to be observed in all survey waves. Among the baseline covariates, only the age of the household head is weakly associated with panel retention, and the magnitude of this effect is negligible. Taken together with the very low overall attrition rates, these results suggest that differential attrition is unlikely to bias our impact estimates in a meaningful way.

Finally, Not all outcomes were collected in every survey wave. Some variables were included from the outset, while others were added later in response to operational constraints and evolving priorities of the implementing agency. For example, the indicators reported in Table B.3 were measured only in the two follow-up surveys, once the project activities were underway. Similarly, food insecurity (FIES) was collected only in the first and second follow-up rounds, after additional funding from GAFSP placed greater emphasis on food security outcomes. We make this timing explicit in the tables and focus our interpretation on the periods for which data are available.

4 | EMPIRICAL FRAMEWORK

The experimental design of this study uses a stratified approach by communities where farms within communities are assigned to a treatment and control group. . The estimation of the program's impact is represented by the following equation:

$$Y_{ij} = \alpha + dD_{ij} + f_j + e_{ij}$$

In this equation, D_{ij} equals one if individual i from community j belongs to the treatment group and zero if the individual belongs to the control group. Moreover, given the

characteristics of the sampling design—specifically, the selection of participants within the communities—it is essential to adjust the regression for community-level fixed effects, denoted as f_j , to account for the effects of sample stratification.

A typical analysis in experimental impact evaluation, particularly in its simplest form, involves comparing means between a treatment group and a control group that have been randomly assigned. Due to the randomness, it is expected that any observed differences after the program’s implementation will result from the participation of one group in the program while the other does not.

However, complications arise when the control group also benefits from the program in some way, such as through the exchange of information with the treatment group. In such cases, a simple comparison may not yield an accurate assessment of the program’s impact. Under the presence of spillovers we interpret our results as a lower bound effects of the program. Future work will analyze spillovers and control for these.

The treatment indicator captures random assignment to start the PDI early (treatment group) versus with a delay (control group). All households in our sample are enrolled in subsistence family agriculture PDIs, so there is no full compliance in take-up of the program. Measures of intensity such as the number of trainings attended combine both supply-side and demand-side factors and do not represent a single causal channel of the intervention. For these reasons, we report the differences between being randomized into the program or out of the program, which can be interpreted as the average treatment effect of being enrolled in the PDI, which we view as the most transparent and policy-relevant estimand in this context.

5 | RESULTS

5.1 | Implementation and take-up

Before comparing treatment and control groups, it is important to describe how the program was implemented in practice. This section shows to what extent the activities and transfers planned by the project actually reached the beneficiaries. Understanding the scale of inputs, training, and assistance provided helps interpret the size and meaning of the impacts reported later.

We present descriptive data of the implementation of the Inclusive Development Projects (PDI). These data come from the program’s administrative records. The first aspect relates to the capitalization of the PDIs, which corresponds to the monetary equivalent of all inputs received by the beneficiaries from the program. On average, participants received an equivalent of between \$1,000 and \$1,500, depending on the type of PDI they are involved in. Of this amount, 75% consists of transferred goods, 14% pertains to technical assistance, 4% to training, and 7% to administrative costs.

Regarding the intensity of training delivered on the ground, [Figure A.3](#) reports the average number of trainings received per beneficiary, by training topic and PDI group in the evaluation sample. As discussed in [Section 2.1](#), the experimental sample is restricted to family agriculture PDIs oriented toward subsistence and community exchange. In this context, “type of PDI” refers to groupings of these subsistence agriculture plans that share a similar productive profile (for example, combinations of basic grains and complementary crops). Each bar in [Figure A.3](#) aggregates all households attached to PDIs in the corresponding group, so the underlying number of beneficiaries differs across types.

The values in [Figure A.3](#) are not necessarily integers because they show the *average* number of trainings per household, rather than the total count of sessions. Not all beneficiaries attended the same number of events within a given topic, and some trainings

were targeted to subsets of households, which generates fractional means. Production- and nutrition-related trainings are the most frequent, with average intensities ranging roughly between one and six sessions per beneficiary across PDI groups. This variation reflects both differences in local priorities and some heterogeneity in implementation across PDIs.

Concerning livestock inventory, [Figure A.4](#) illustrates the number of birds and pigs received by each beneficiary in each PDI of the sample. The number of birds varies between 10 and 30 per beneficiary, while the number of pigs delivered ranges from 1 to 9 pigs per beneficiary. In conclusion, the administrative data suggests that the program fulfilled the designed activities and the committed transfers.

5.1.1 | Nutrition related practices

We start the analysis of program effects with outcomes directly linked to nutrition and household behavior. Improving hygiene, food preparation, and small-scale agricultural diversification were key objectives of the program. This section examines whether participants changed their nutrition-related practices, which represent the first step toward better diets and food security.

[Table B.3](#) presents the impact on nutrition-sensitive practices, which are classified into two groups: hygiene practices and agricultural practices. Except for the variables related to the probability of establishing more than one crop (agricultural or fruit tree) and raising animals (pigs and birds), the results presented here correspond to indices constructed using Principal Component Analysis (PCA), used to reduce the dimensionality of a series of variables that describe a phenomenon. In our case, all questions corresponding to each dimension of the questionnaire were used for each index, and to measure the impact, the score corresponding to the values provided by the PCA was utilized.

Regarding hygiene practices (panel a), a statistically significant and positive effect is observed in food preparation and preservation, hygiene, and food handling, alongside a negative effect in the management of water for household consumption, both in the intermediate and final follow-ups. The numbers are interpreted as standard deviations, with changes greater than 0.2 standard deviations considered large changes. Thus, the program increased food preparation and preservation by 0.167 standard deviations during the follow-up survey and by 0.278 standard deviations in the final survey. This implies that, for every food preparation activity conducted by the control group, the treatment group performs 1.36 activities. In terms of food preservation, for every activity reported by the control group, the beneficiaries of the PAIPSAN-CCN report performing 1.45 activities.

If we analyze agricultural practices (panel b), positive and statistically significant effects are found across all analyzed variables. It is observed that, compared to the control group, the probability of establishing more than one agricultural crop in the production unit increased by 3.3 times (7.7 percentage points) for the treatment group. Additionally, the probability of establishing more than one fruit tree increased by 5.8 times compared to the control group (14 percentage points).

Furthermore, the probability of raising pigs increased by 5.34 times (17.1 percentage points) for the treatment group, and that of raising chickens increased by 7.86 times (16.5 percentage points). In this regard, it is explained that approximately 20% of families receiving the PAIPSAN-CCN are involved in pig raising, with similar results for poultry.

Finally, positive and statistically significant effects are also observed in the use of improved seeds for basic grains, fortified varieties, bio-inputs for fertilization, and post-harvest management practices. These practices may contribute to food availability and improve agricultural production. These results are interpreted as changes in standard deviations. For basic grains, the results indicate that the treatment group increases the use of basic grains by

0.7 standard deviations. This means that for every basic grain utilized by the control group, the treatment group uses 1.22 grains.

5.1.2 | Post-Harvest: Use of Equipment and Technologies and Implementation of Practices in the Production Unit

A second mechanism expected to affect production and food security was the improvement in post-harvest management and technology use. These activities help reduce food losses, increase storage capacity, and maintain product quality over time. In this section, we test whether the program led to greater use of post-harvest equipment and better agricultural practices among beneficiaries.

Similar to the case of implementing nutrition-sensitive practices, indices were constructed using PCA based on the use of equipment and practices in the production unit, as well as the use of technologies and good agricultural practices. The impact results for these variables are shown in [Table B.4](#).

Regarding equipment used in the production unit, the results show that the treatment group increased its use by 0.152 standard deviations in the final survey, and post-harvest management practices increased by 0.389 and 0.211 standard deviations in the follow-up and final surveys, respectively. This means that for every post-harvest management activity reported by the control group, the beneficiaries receiving PAIPSAN-CCN perform 1.8 post-harvest activities in the follow-up and 1.38 activities in the final survey.

The increase in the implementation of post-harvest activities is linked to the provision of tools to beneficiaries for developing productive activities. As these activities and the necessary tools are part of the investment that all farmers make, they are always greater in the treatment group.

To increase the volume of post-harvest management, investments were made in using infrastructure such as sheds, silos, and barrels to achieve greater storage capacity, alongside developing skills in techniques such as selection, drying, moisture control, and good storage practices. Similar magnitudes are found for the use of technologies and good livestock practices.

5.1.3 | Type of Training Received

Training is central for understanding how community-based projects change behavior. Through group sessions, farmers can learn, exchange experiences, and coordinate production decisions. This subsection presents the evidence on participation in different types of training—such as management, associativity, and value addition—and shows whether the program successfully activated these learning channels.

Regarding the type of training received, the results show an effect on participation in training sessions for associativity, management, and value addition and transformation, but not in the establishment of sales alliances. The impact on these variables can be found in [Table B.5](#). For example, in the intermediate follow-up, the probability of participating in associativity training increases by 16 percentage points, and in the final follow-up, treatment beneficiaries increase their probability of participating in the same training sessions by 9.7 percentage points compared to the control group.

Furthermore, the probability of receiving management training is 7.2 percentage points higher for the treatment group in the entire sample during the intermediate follow-up. In the final follow-up, the effect of receiving management training increases to 8.4 percentage points for the entire sample.

Finally, the impact of the treatment on the probability of attending training sessions for

value addition and transformation, as well as for the establishment of sales alliances, is shown. For the entire sample, attendance at training sessions for value addition and transformation increased by 4.3 percentage points for the treatment group in the intermediate follow-up.

5.2 | Agricultural Production

After examining adoption of practices and technologies, we now turn to agricultural outcomes. This section studies whether the program increased the probability of producing and the number of crops grown across seasons. The results help assess if the program translated behavioral changes into higher and more diversified production.

5.2.1 | Probability of Producing and Number of Seasonal Crops

Seasonal production is a key indicator of resilience for small farmers. By comparing results across the *apante* and *primera* cycles, we can see whether the intervention helped households sustain or expand production under different weather and resource conditions. This section looks at how production levels changed throughout the agricultural year.

Table B.6 shows the impact on the probability of producing and the number of crops reported by beneficiaries during each season of the year.

In Nicaragua, agricultural production follows three main seasonal cycles that are defined by rainfall patterns and soil moisture. The *primera* season, which runs roughly from May to August, coincides with the onset of the rains and represents the primary planting period for staple crops such as maize and beans. This cycle provides most of the food consumed by rural households. The *postrera* season, from September to November, takes advantage of residual moisture after the main rains and is mainly devoted to short-cycle crops—particularly beans and sorghum—serving as a secondary harvest that reinforces household food security and generates surplus for sale. Finally, the *apante* season occurs between December and March, during the dry season, and is only feasible in areas with irrigation or high residual humidity, such as the Caribbean region. This cycle supports the production of beans, rice, and vegetables, stabilizing food availability during the dry months. Together, these three agricultural seasons structure Nicaragua’s farming calendar and are central to understanding variations in yields, technology adoption, and food security outcomes among smallholder farmers.

The intermediate follow-up corresponds to the *apante* season, while the final follow-up pertains to the *primera* season. The program increased the probability of producing any crop in both seasons (*apante* and *primera*), with a more substantial effect observed during the *apante* season. The same trend is noted for the number of crops, indicating more diversified production during this time.

For the treatment group, the program increased the probability of producing during the *apante* season by 7.5 percentage points and by 3.8 percentage points during the *primera* season. In terms of crop quantity, the treatment group experienced an increase of 0.5 crops during *apante* due to the program and 0.2 crops during *primera*. These additional crops include vegetables (e.g., tomato, chiltomas, carrot), fortified maize and beans, cacao, and coffee within agroforestry and fruit systems.

5.2.2 | Basic Grains

Maize and beans are the main staple foods in Nicaragua and the basis of household consumption and income. If the program was effective, we should observe higher production

and yields for these crops. This subsection quantifies those effects and explores how the adoption of improved seeds and practices translated into productivity gains.

For maize and beans, the impact on the probability of production, area planted in *manzanas*, quantity produced in quintales, yield in quintales per *manzanas*, and the quantity in quintales of production allocated to storage, seeds, loss, animal consumption, sale, and self-consumption is presented.⁵

Table B.7 show the results for maize production. An increase is observed in the probability of producing and in the quantity produced during both the *apante* and *primera* seasons, as well as in yield during the *apante* season. No statistically significant effects are observed in *primera* yield. The probability of producing maize increased by 9.2 percentage points in *apante* and by 4.2 percentage points in *primera*; the number of quintales increased by 55.92% in *apante* for the treatment group and by 33.33% in *primera*, with yield rising by 88% in *apante*.

Beneficiaries' efforts to produce high-quality maize this cycle are attributed to environmental conditions during production, evidenced by the 88% increase in yield, combined with crop management and the application of various practices promoted by the project that improve yield.

Table B.8 show the results for bean production. Similar to maize, an increase in the probability of production is observed in both *apante* and *primera*, with a larger effect in *apante*, as well as increases in quantity produced and yield.

Our results show that the probability of producing beans increased by 17 percentage points in *apante* and by 3 percentage points in *primera*. The quantity produced increased by 4.735 quintales and yield by 7.99 qq/mz in *apante*. No statistically significant effects are observed for quantity produced or yield in *primera*.

5.3 | Climate-Smart Agricultural Practices

Beyond specific crops, the program aimed to promote sustainable and climate-smart farming practices. These include soil and water management, use of bio-inputs, and livestock technologies that increase resilience to climate shocks. This section evaluates whether such practices were adopted by beneficiary households.

For the analysis of good agricultural practices in the production unit, a Principal Component Analysis (PCA) was conducted, similar to previous sections, using several variables related to for perennial and semi-perennial crops. The impact results are shown in **Table B.9**. Positive and statistically significant results are observed for annual crops in both seasons (*apante* and *primera*), but not for perennial and semi-perennial crops.

We also analyze results regarding the use of production technologies in agricultural crops. Each variable in the panel corresponds to the index constructed through Principal Component Analysis (PCA). Positive and statistically significant effects are observed in the use of seeds and bio-inputs in both the intermediate and final follow-ups, in the use of livestock technologies during the intermediate follow-up, and in the use of agro-ecological technologies during the final follow-up.

Similarly, indices were constructed using PCA to analyze the impact on good agricultural practices. Positive and statistically significant results are observed in all analyzed good agricultural practices (production systems, soil and water management practices, livestock

⁵In Nicaragua and much of Central America, agricultural land area is commonly measured in *manzanas* rather than hectares. One *manzana* is a traditional unit of land area equivalent to 0.7 hectares (approximately 1.73 acres). The measure originates from colonial-era surveying systems and remains the standard unit used by farmers, local agencies, and agricultural programs for reporting plot size, yields, and input use. For comparability, all reported areas can be converted to hectares by multiplying *manzanas* by 0.7.

practices), both in the intermediate and final follow-ups.

5.4 | Inputs

The program also sought to strengthen access to productive inputs and community organizations, which are key for smallholder development. By providing seeds, tools, technical support, and opportunities for cooperation, it aimed to overcome market and coordination failures. This section reports how the program affected access to these resources and participation in producer groups.

Table B.10 presents the results regarding the probability of participating in any productive or community organization and the production inputs received by the program beneficiaries. An increase is observed in the probability of participating in productive and community organizations during both the intermediate and final follow-ups, as well as in the probability of receiving seeds, technical assistance, commercial support, and technology and equipment.

According to panel a) of the table, the probability of belonging to a productive organization increased by 19 percentage points in the intermediate follow-up and by 10.2 percentage points in the final follow-up. On the other hand, the probability of belonging to a community organization increased by 6.1 percentage points in the intermediate follow-up and by 3 percentage points in the final follow-up.

In panel b), it can be seen that the probability of receiving seeds increased by 24.6 percentage points, the probability of receiving technical assistance increased by 0.9 percentage points, commercial support by 16.6 percentage points, and technology and equipment by 2.9 percentage points in the intermediate follow-up.

In the final follow-up, the probability of receiving seeds decreased to 15.6 percentage points, while the probability of receiving technical assistance increased to 21.1 percentage points, the probability of receiving commercial support increased to 18.7 percentage points, and the probability of receiving technology and equipment increased by 18.6 percentage points.

5.5 | Satisfaction, Quality of Life, and Food Insecurity

Finally, we analyze outcomes that reflect household well-being more broadly. Improvements in satisfaction, perceived quality of life, and food security indicate whether the program's economic effects translated into better living conditions. This section looks at both short-term improvements and whether they were sustained over time.

Beneficiary satisfaction was measured based on perceptions regarding the yields of the last harvest, household nutrition, and quality of life. To assess the impact, we considered those who reported being satisfied or very satisfied in each context.

Table B.11 presents the results concerning the impact on satisfaction with production, food, and household quality of life. Positive and statistically significant effects are observed across these three variables during both periods.

The probability of being very satisfied or satisfied with the harvest increased by 13.4 percentage points in the intermediate follow-up and by 6 percentage points in the final follow-up. Additionally, the impact on satisfaction with household food also increased by 5.5 percentage points in the final follow-up. Lastly, the perception of quality of life increased by 5.3 percentage points in the intermediate follow-up and by 3.8 percentage points in the final follow-up.

Next, the program's impact was studied on the global food security scale and on medium and high levels of insecurity. This scale, designed by the FAO with its project "Voices of the

Hungry,” attempts to measure severity through a continuous scale and involves responses to eight simple questions about adequate access to food. The concepts underlying these questions have a long history and refer to the food security experiences individuals may face, emerging from ethnographic studies aimed at understanding the experience of hunger.

Food insecurity is viewed as a continuous scale of severity. Research in the United States and other parts of the world has revealed that the experience of food insecurity is characterized in its early stages by uncertainty and anxiety about food access, leading to changes in diet quality (such as less balanced and more monotonous). As severity increases, the quantity of food consumed decreases, meals are skipped, and at the most severe level, people stop eating. These dimensions of food insecurity have been documented in various studies and appear to be common across different cultures and countries.

Responses to the scale questions can be “yes” or “no,” and a higher score indicates a greater level of food insecurity. For instance, question 1 asks, “Did you or other members of the household worry about not having enough food due to lack of money or other resources?” A person responding “yes” would contribute to a higher score. Consequently, a person with a score of 8 on the scale is experiencing the highest level of food insecurity, while someone with a score of 2 is experiencing a very low level of insecurity. Based on this, the authors consider two important thresholds for analysis based on a person’s score:

- Medium level of insecurity: if the score is greater than 4.
- High level of insecurity: if the score is greater than 7.

As one of the program’s main objectives, reducing this indicator becomes essential to improving the well-being and health of the population and future generations.

The impact results in [Table B.12](#) indicate that, in the intermediate follow-up, there is a decrease in the levels of food insecurity experienced by families, both on the global scale and at medium and high levels of insecurity; however, these results do not persist in the final follow-up.

In the intermediate follow-up, it is observed that the level of food insecurity decreased by 0.5 points on the global scale for the treatment group, the probability of experiencing a medium level of insecurity decreased by 6 percentage points, and the probability of having a high level of insecurity decreased by 4 percentage points. In the final follow-up, no significant differences are found between treatment and control beneficiaries. While both groups experience a drop in their levels of food insecurity, the control group shows a greater decline, leading to lower food insecurity levels in both groups. For example, data show that in the intermediate follow-up, 21.9% of control group beneficiaries reported high levels of food insecurity, compared to 17.5% in the treatment group. In the final follow-up, 6.4% of control beneficiaries present high levels of food insecurity compared to 8.9% in the treatment group. In both groups, levels decrease considerably between periods.

6 | CONCLUSION

This paper provides experimental evidence on the effects of a community-driven development (CDD) program explicitly designed to promote climate-smart agriculture (CSA) and food security in Latin America. Using a within-community randomized design, we estimate the causal effects of the PAIPSAN project implemented in rural Nicaragua. The results show that community-based delivery substantially increased the adoption of improved agricultural inputs—such as certified seeds, bio-fertilizers, and storage systems—alongside broader improvements in livestock ownership, participation in producer organizations,

and nutrition-sensitive practices. These behavioral and productive changes translated into higher yields of maize and beans, increased diversification, and measurable improvements in food security and self-reported well-being.

Beyond the empirical results, this paper makes three main contributions to the literature. First, it helps us understand better when and how community-driven development (CDD) programs can increase agricultural productivity and household welfare. Most CDD evaluations focus on local governance or participation, while evidence on productive outcomes is still limited (Beath et al., 2017; Humphreys et al., 2019; Saguin, 2018). Our results show that participatory models can also improve material conditions, offering a successful example of decentralized development.

In addition, the paper connects the CDD and climate-smart agriculture (CSA) literatures by studying whether community delivery can reduce coordination and risk barriers that limit the adoption of sustainable technologies (Arslan et al., 2015; Amadu et al., 2020). The findings suggest that social learning, joint management of inputs, and collective monitoring are key channels through which participation increases productivity and resilience. Finally, by using data from several agricultural seasons, we are able to follow short- and medium-term changes in adoption, yields, and welfare, and to explore differences by gender, income, and production system. Taken together, these results help explain the mixed evidence on CDD programs and clarify the mechanisms through which participatory agricultural interventions can generate lasting improvements in rural livelihoods and climate resilience.

While the randomized design provides credible evidence of causal impacts, several limitations should be noted. First, because randomization occurred within communities that shared training sessions, demonstration plots, and collective storage facilities, spillovers between treated and control households are likely. Such diffusion would transmit knowledge and technologies beyond the treated group, thereby biasing our estimated treatment effects toward zero. The positive impacts we document should thus be interpreted as lower-bound estimates of the program's total effect when implemented at scale. Second, some outcomes—particularly yields and food security—rely on self-reported measures, which may contain reporting error or recall bias, although the magnitude of the effects and their consistency across data sources mitigate this concern. Third, despite tracking households across two agricultural seasons, we cannot rule out short-term attenuation or season-specific shocks as explanations for the decline in some outcomes by the final survey. Finally, our study captures effects over a two-year horizon and does not measure long-term sustainability or general equilibrium effects, such as market price responses or spillovers to neighboring communities. These caveats suggest that our estimates are conservative and that future work should examine persistence and system-wide impacts over longer periods.

A natural limitation of this study is that it cannot speak directly to the cost-effectiveness of the intervention. The analysis documents sizeable gains in technology adoption, yields and food security, and the implementation section reports average program costs per beneficiary and per PDI type, but I do not observe sufficiently detailed and reliable data on output prices or marketing margins to translate these physical gains into changes in farm profits or household income. As a result, the paper provides evidence on the technical effectiveness of a community-based, climate-smart program—showing that it can raise production and improve food security in the short and medium run—but it cannot assess whether these benefits justify the fiscal and implementation costs under alternative pricing and market conditions. A useful extension for future work would be to combine similar experimental designs with high-frequency data on prices, input costs and marketing channels in order to recover more precise estimates of economic returns and benefit-cost ratios.

Overall, the findings highlight the potential of community-driven approaches to scale up climate-smart agriculture and strengthen food security in rural areas. By combining

productive investments with local participation, programs like PAIPSAN can enhance technology adoption, improve resilience to climate shocks, and foster inclusive rural development. These results suggest that integrating community-based delivery mechanisms into national agricultural and food security strategies can be an effective policy tool for promoting sustainable growth and reducing vulnerability among smallholder farmers.

| Acknowledgements

We are especially grateful to Adriana Camacho, Karen Macours, Rachid Laajaj for helpful comments on a first version of this draft and seminar participants at the *Rural World in Latin America and the Caribbean Workshop* at CAF. We also thank the Banco de Desarrollo de América Latina y el Caribe (CAF) for funding this project through its call *The rural world in Latin America and the Caribbean*. Ela Diaz provided excellent research assistance for an earlier version of this project. This project also benefited largely from many participants along its implementation including Brenda Mendieta-Arroyo, Augusto Mendoza, Leonardo Lucchetti, Pablo Valdivia, Juan Carlos Parra, Denise van Wissen, Carlos Seizar, Mario Navarrete from the World Bank implementation team; and Isidro Mendoza, Guillermina Torres, Zuyapa Ortega, Kenia Lazo, and Joel Velez from MEFCCA. All errors remain our own.

REFERENCES

- Alatas, V., Banerjee, A., Hanna, R., Olken, B. A., Purnamasari, R. and Wai-Poi, M. (2019) Does elite capture matter? local elites and targeted welfare programs in indonesia. In *AEA Papers and Proceedings*, vol. 109, 334–339. American Economic Association.
- Alatas, V., Banerjee, A., Hanna, R., Olken, B. A. and Tobias, J. (2012) Targeting the poor: Evidence from a field experiment in indonesia. *American Economic Review*, **102**, 1206–1240.
- Amadu, F. O., McNamara, P. E. and Miller, D. C. (2020) Understanding the adoption of climate-smart agriculture: A farm-level typology with empirical evidence from southern malawi. *World Development*, **126**, 104692.
- Antón, J., Cattaneo, A., Kimura, S. and Lankoski, J. (2013) Agricultural risk management policies under climate uncertainty. *Global Environmental Change*, **23**, 1726–1736.
- Araujo, M. C., Ferreira, F. H., Lanjouw, P. and Özler, B. (2008) Local inequality and project choice: Theory and evidence from ecuador. *Journal of Public Economics*, **92**, 1022–1046.
- Arslan, A., McCarthy, N., Lipper, L., Asfaw, S., Cattaneo, A. and Kokwe, M. (2015) Climate smart agriculture? assessing the adaptation implications in zambia. *Journal of Agricultural Economics*, **66**, 753–780.
- Avdeenko, A. and Gilligan, M. J. (2015) International interventions to build social capital: Evidence from a field experiment in sudan. *American Political Science Review*, **109**, 427–449.
- Bank, W. (2025) Community-driven development. <https://www.worldbank.org/en/topic/communitydrivendevelopment>. URL: <https://www.worldbank.org/en/topic/communitydrivendevelopment>. Last updated April 30, 2025.
- Battisti, D. S. and Naylor, R. L. (2009) Historical warnings of future food insecurity with unprecedented seasonal heat. *Science*, **323**, 240–244.
- Beath, A., Christia, F. and Enikolopov, R. (2017) Direct democracy and resource allocation: Experimental evidence from afghanistan. *Journal of Development Economics*, **124**, 199–213.
- Bernard, T., Collion, M.-H., De Janvry, A., Rondot, P. and Sadoulet, E. (2008) Do village organizations make a difference in african rural development? a study for senegal and burkina faso. *World Development*, **36**, 2188–2204.
- Borisova, E., Smyth, R. and Zakharov, A. (2024) Autocratic policy and the accumulation of social capital: The moscow housing renovation program. *American Political Science Review*, **118**, 1110–1130.
- Campbell, B. M., Vermeulen, S. J., Aggarwal, P. K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A. M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P. K. et al. (2016) Reducing risks to food security from climate change. *Global Food Security*, **11**, 34–43.
- Casey, K. (2018) Radical decentralization: Does community-driven development work? *Annual Review of Economics*, **10**, 139–163.
- Casey, K., Glennerster, R. and Miguel, E. (2012) Reshaping institutions: Evidence on aid impacts using a preanalysis plan. *The Quarterly Journal of Economics*, **127**, 1755–1812.
- Cooke, B. and Kothari, U. (2001) *Participation: The New Tyranny?* Zed Books.
- Dasgupta, A. and Beard, V. A. (2007) Community driven development, collective action and elite capture in indonesia. *Development and Change*, **38**, 229–249.
- Heß, S., Jaimovich, D. and Schündeln, M. (2021) Development projects and economic networks: Lessons from rural gambia. *The Review of Economic Studies*, **88**, 1347–1384.
- Humphreys, M., de la Sierra, R. S. and Van der Windt, P. (2019) Exporting democratic practices: Evidence from a village governance intervention in eastern congo. *Journal of Development Economics*, **140**, 279–301.

- Jayne, T. S., Sitko, N. J., Mason, N. M. and Skole, D. (2018) Input subsidy programs and climate smart agriculture: Current realities and future potential. *Climate Smart Agriculture: Building Resilience to Climate Change*, 251–273.
- Kahsay, G. A. and Bulte, E. (2021) Internal versus top-down monitoring in community resource management: Experimental evidence from ethiopia. *Journal of Economic Behavior & Organization*, **189**, 111–131.
- Knowler, D. and Bradshaw, B. (2007) Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, **32**, 25–48.
- Krishna, A., Kambewa, D., Tchuwa, F., Kasonga, F. and Higdon, P. (2025) What do communities feel about community-driven development? learning from investigations in rural malawi. *World Development Perspectives*, **38**, 100692.
- Labonne, J. and Chase, R. S. (2011) Do community-driven development projects enhance social capital? evidence from the philippines. *Journal of Development Economics*, **96**, 348–358.
- Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K. et al. (2014) Climate-smart agriculture for food security. *Nature Climate Change*, **4**, 1068–1072.
- Lund, J. F. and Saito-Jensen, M. (2013) Revisiting the issue of elite capture of participatory initiatives. *World Development*, **46**, 104–112.
- Madajewicz, M., Tompsett, A. and Habib, M. A. (2021) How does delegating decisions to communities affect the provision and use of a public service? evidence from a field experiment in bangladesh. *Journal of Development Economics*, **150**, 102609.
- Mansuri, G. and Rao, V. (2004) Community-based and-driven development: A critical review. *The World Bank Research Observer*, **19**, 1–39.
- (2012) Can participation be induced? some evidence from developing countries. *Some Evidence from Developing Countries (July 1, 2012)*. *World Bank Policy Research Working Paper*.
- McNamara, K. E., Clissold, R., Westoby, R., Piggott-McKellar, A. E., Kumar, R., Clarke, T., Namoumou, F., Areki, F., Joseph, E., Warrick, O. et al. (2020) An assessment of community-based adaptation initiatives in the pacific islands. *Nature Climate Change*, **10**, 628–639.
- Nguyen, T. C. and Rieger, M. (2017) Community-driven development and social capital: Evidence from morocco. *World Development*, **91**, 28–52.
- Nkonya, E., Phillip, D., Mogues, T., Pender, J. and Kato, E. (2012) Impacts of community-driven development programs on income and asset acquisition in africa: The case of nigeria. *World Development*, **40**, 1824–1838.
- Olken, B. A. (2010) Direct democracy and local public goods: Evidence from a field experiment in indonesia. *American political science review*, **104**, 243–267.
- Park, A. and Wang, S. (2010) Community-based development and poverty alleviation: An evaluation of china's poor village investment program. *Journal of Public Economics*, **94**, 790–799.
- Platteau, J.-P. (2004) Monitoring elite capture in community-driven development. *Development and Change*, **35**, 223–246.
- Pradhan, M., Suryadarma, D., Beatty, A., Wong, M., Gaduh, A., Alisjahbana, A. and Artha, R. P. (2014) Improving educational quality through enhancing community participation: Results from a randomized field experiment in indonesia. *American Economic Journal: Applied Economics*, **6**, 105–126.
- Saguin, K. (2018) Why the poor do not benefit from community-driven development: Lessons from participatory budgeting. *World Development*, **112**, 220–232.

- Salinger, A. P., Charles, I., Francis, N., Batagol, B., Meo-Sewabu, L., Nasir, S., Bass, A., Habsji, H., Malumu, L., Marzaman, L. et al. (2024) “people are now working together for a common good”: The effect on social capital of participatory design for community-level sanitation infrastructure in urban informal settlements. *World Development*, **174**, 106449.
- Steenwerth, K. L., Hodson, A. K., Bloom, A. J., Carter, M. R., Cattaneo, A., Chartres, C. J., Hatfield, J. L., Henry, K., Hopmans, J. W., Horwath, W. R. et al. (2014) Climate-smart agriculture global research agenda: Scientific basis for action. *Agriculture & Food Security*, **3**, 1–39.
- Stiglitz, J. E. (2002) Participation and development: Perspectives from the comprehensive development paradigm. *Review of development economics*, **6**, 163–182.
- White, H., Menon, R. and Waddington, H. (2018) Community-driven development: Does it build social cohesion or infrastructure? a mixed-method evidence synthesis.
- Wong, S. and Guggenheim, S. (2018) Community-driven development: Myths and realities. *World Bank Policy Research Working Paper*.

A | FIGURES



FIGURE A.1 Project Coverage

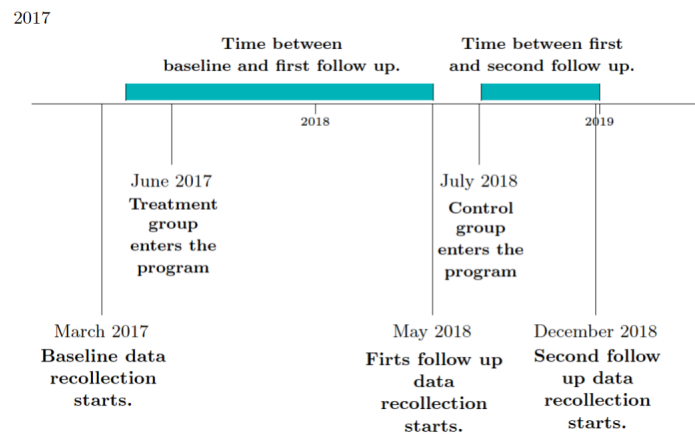
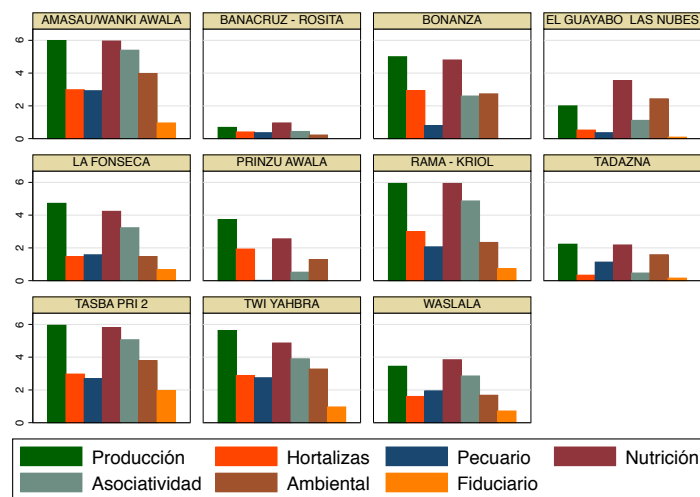


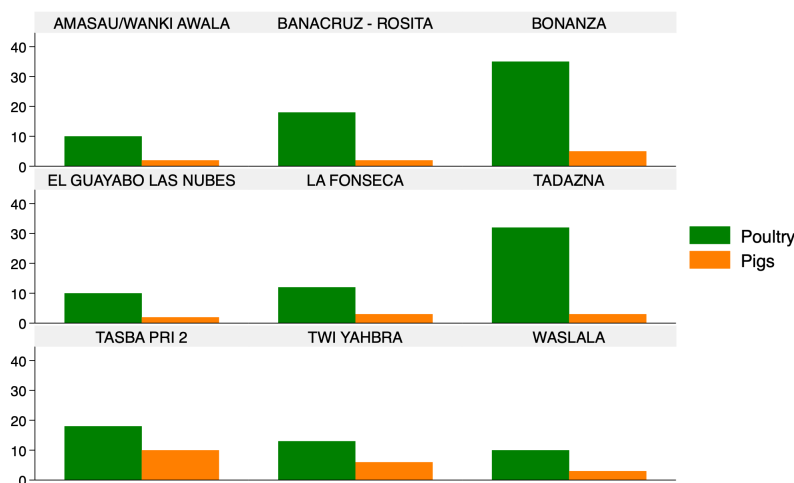
FIGURE A.2 Project Timeline

FIGURE A.3 Number of training received by Beneficiaries by type and PDI



Note: The labels refer to the main thematic focus of activities within the subsistence family agriculture PDIs. “Producción” covers general crop and farm management; “Fiduciario” refers to basic financial and administrative management (record-keeping, budgeting, compliance with project rules); “Hortalizas” focuses on vegetable production; “Pecuario” on small livestock and animal husbandry; “Nutrición” on nutrition-sensitive practices, food preparation and dietary counselling; “Asociatividad” on group organisation, producer associations and collective marketing; and “Ambiental” on environmental management and climate-smart practices, including soil conservation, water management and agroforestry.

FIGURE A.4 Number of birds and pigs received by Beneficiaries by type and PDI



B | TABLES

TABLE B.1 Baseline Balance in Sample

Description	Treatment Group			Control Group			p-value
	Mean	Std. Err.	Obs	Mean	Std. Err.	Obs	
Age in years	40.621	14.461	902	39.993	14.031	905	0.346
Female (=1)	0.304	0.460	902	0.275	0.447	905	0.182
Mestizo (=1)	0.711	0.454	902	0.750	0.433	905	0.000
Can Read and Write	0.718	0.450	902	0.675	0.469	905	0.054
Main Activity: Agriculture	0.941	0.235	902	0.959	0.198	905	0.066
Main Activity: Livestock	0.804	0.397	902	0.780	0.414	905	0.201
Main Activity: Small Businesses	0.098	0.297	902	0.082	0.274	905	0.258
Main Activity: Other	0.057	0.231	902	0.076	0.266	905	0.046
Number of Household Members	4.81	2.039	902	4.827	3.314	905	0.885
Housing Type House (=1)	0.969	0.174	902	0.973	0.161	905	0.511
Floor Type Earth (=1)	0.480	0.500	902	0.490	0.500	905	0.736
Roof Type Zinc (=1)	0.922	0.268	902	0.917	0.276	905	0.657
Energy Source: Electric Grid (=1)	0.340	0.474	902	0.317	0.466	905	0.171
Own Housing with Deed (=1)	0.397	0.490	902	0.417	0.493	905	0.431
Own Housing without Deed (=1)	0.468	0.499	902	0.467	0.499	905	0.888
Water from Communal or Private Well (=1)	0.350	0.477	902	0.331	0.471	905	0.220
Water from Spring (=1)	0.264	0.441	902	0.277	0.448	905	0.432
Water from River or Stream (=1)	0.153	0.360	902	0.152	0.360	905	0.901
Unimproved Latrine (=1)	0.302	0.459	902	0.295	0.456	905	0.811
Improved Latrine (=1)	0.441	0.497	902	0.422	0.494	905	0.446
Language Spoken: Spanish (=1)	0.340	0.474	902	0.294	0.456	905	0.018
Language Spoken: Misquita (=1)	0.950	0.218	901	0.955	0.208	903	0.577
No Education	0.257	0.437	901	0.216	0.412	903	0.000
Higher Education	0.072	0.259	902	0.055	0.229	905	0.156
Employment (=1)	0.027	0.161	902	0.034	0.182	905	0.351
Was Sick for at Least 1 Day (=1)	0.271	0.444	902	0.275	0.447	905	0.784
Had Respiratory Illness (=1)	0.309	0.462	902	0.306	0.461	905	0.852
Had Diarrhea (=1)	0.284	0.451	902	0.286	0.452	905	0.970
INB=1 (Extreme Poverty)	0.049	0.216	902	0.043	0.203	905	0.564
Produced in <i>Apante</i> (=1)	0.777	0.416	902	0.773	0.419	905	0.723
Produced in <i>Primera</i> (=1)	0.701	0.458	902	0.704	0.457	905	0.953
Produced in <i>Postrera</i> (=1)	0.303	0.460	902	0.343	0.475	905	0.031
Total Productivity <i>Apante</i>	0.681	0.466	902	0.696	0.460	905	0.413
Total Productivity <i>Primera</i>	52.925	129.725	632	70.797	526.171	637	0.406
Total Productivity <i>Postrera</i>	17.764	24.348	272	15.940	22.881	310	0.571

This table reports baseline means and standard deviations for key demographic and socioeconomic characteristics of households in the treatment and control groups. The final sample includes individuals with complete information across all survey rounds. Differences in means are tested using two-sided t-tests that account for the stratified randomization design described in equation (1). Reported p-values correspond to the null hypothesis of equality in means between groups. Consistent with random assignment, no statistically significant differences are observed across core baseline characteristics, indicating that the treatment and control groups are balanced. Minor differences in a few variables are within the range expected under random sampling.

TABLE B.2 Probability of Remaining in the Longitudinal Sample

	(1)	(2)
	OLS, community FE	OLS, community FE
Treat	0.018 (0.012)	0.018 (0.012)
Household size		0.003 (0.003)
Head can read and write		-0.003 (0.014)
Household head is female		0.011 (0.014)
Age of household head		0.000** (0.000)
Observations	1,810	1,810

Notes: The dependent variable is an indicator equal to 1 if the household is observed in all survey waves (longitudinal sample). Both columns report linear probability models (OLS) with community fixed effects. Column (1) includes only the treatment indicator; column (2) additionally controls for household size, literacy of the household head, sex of the household head, and age of the household head. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

TABLE B.3 Impact on Implementing Nutrition/Climate Sensitive Practices

Panel A: Nutrition sensitive practices

	Food Preparation and Preservation				Food Hygiene and Handling			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.153** (0.076)	0.167** (0.076)	0.277*** (0.080)	0.278*** (0.080)	-0.009 (0.068)	0.167** (0.076)	0.173** (0.071)	0.278*** (0.080)
Control Mean	-0.062	-0.062	-0.163	-0.163	-0.014	-0.014	-0.087	-0.087

Panel B: Climate sensitive practices (Follow-up II Only)

	More Than One Crop		More Than One Fruit Tree		Raises Pigs		Raises Birds	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.076*** (0.011)	0.077*** (0.011)	0.141*** (0.012)	0.140*** (0.012)	0.171*** (0.014)	0.170*** (0.014)	0.165*** (0.014)	0.165*** (0.014)
Control Mean	0.023	0.023	0.024	0.024	0.032	0.032	0.021	0.021
	Staple Grains		Biofortified Varieties		Bio-inputs		Post-harvest Management	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.699*** (0.068)	0.704*** (0.068)	0.451*** (0.073)	0.452*** (0.073)	0.194*** (0.063)	0.193*** (0.064)	0.439*** (0.054)	0.442*** (0.054)
Control Mean	-0.333	-0.333	-0.209	-0.209	-0.090	-0.090	-0.206	-0.206
Observations	1,568	1,568	1,568	1,568	1,568	1,568	1,568	1,568
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes	No	Yes	Yes	No

This table reports ordinary least squares estimates of the program's impact. In columns 1 and 3, 5 and 7 of panel a), the effect of the treatment is shown at intermediate and final follow-up (respectively) controlled for fixed effects by community. In columns 2 and 4, 6 and 8, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. Panel b) shows the program's impact at the final follow-up. In columns 1, 3, 5, and 7, the effect of the treatment is shown controlled for fixed effects by community, and in columns 2, 4, 6, and 8, the effect of the treatment is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.4 Impact on Post-Harvest: Use of Equipment and Technologies and Implementation of Practices

<i>Panel A: Equipment and Practices in the Productive Unit</i>								
	Equipment Used				Management Practices			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.014 (0.052)	0.030 (0.052)	0.161*** (0.050)	0.152*** (0.051)	0.400*** (0.073)	0.389*** (0.073)	0.211*** (0.076)	0.201*** (0.077)
Control Mean	-0.013	-0.013	-0.074	-0.074	-0.223	-0.223	-0.105	-0.105
Observations	1568	1568	1568	1568	1568	1568	1568	1568
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes	No	Yes	Yes	No
<i>Panel B: Technologies and Good Agricultural Practices</i>								
	Baseline	Follow-up I		Follow-up II				
	(1)	(2)	(3)	(4)	(5)			
Treatment = 1	0.111 (0.070)	0.401*** (0.070)	0.382*** (0.071)	0.301*** (0.079)	0.287*** (0.079)			
Control Mean	-0.056	-0.227	-0.227	-0.156	-0.156			
Observations	1810	1678	1678	1678	1678			
Community FE	Yes	Yes	Yes	Yes	Yes			
Demographic Controls	No	No	Yes	No	Yes			

This table reports ordinary least squares estimates of the program's impact. In columns 1 and 3, 5 and 7 of panel a), the effect of the treatment is shown at intermediate and final follow-up (respectively), controlled for fixed effects by community. In columns 2 and 4, 6 and 8, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. In column 1 of panel b), the effect of the treatment at baseline is shown. In columns 2 and 4, the effect at intermediate and final follow-up (respectively) is controlled for fixed effects by community. In columns 3 and 5, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.5 Attending Probability and Training Evaluation

<i>Panel A: Attending training and perception of training</i>								
	Probability of Attending				Attended at Least Three Trainings			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.175*** (0.015)	0.175*** (0.015)	0.219*** (0.016)	0.216*** (0.016)	0.102*** (0.012)	0.101*** (0.012)	0.090*** (0.013)	0.090*** (0.013)
Control Mean	0.097	0.097	0.078	0.078	0.039	0.039	0.037	0.037
	Rated as Good or Very Good				Spouse Attended			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.170*** (0.015)	0.170*** (0.015)	0.190*** (0.016)	0.188*** (0.016)	0.140*** (0.015)	0.101*** (0.012)	0.108*** (0.015)	0.090*** (0.013)
Control Mean	0.098	0.098	0.102	0.102	0.066	0.066	0.086	0.086
<i>Panel B: Type of training attended</i>								
	Associativity				Administration			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.153*** (0.017)	0.156*** (0.017)	0.097*** (0.016)	0.097*** (0.016)	0.072*** (0.010)	0.073*** (0.010)	0.084*** (0.015)	0.083*** (0.015)
Control Mean	0.096	0.096	0.158	0.158	0.020	0.020	0.080	0.080
	Value Addition and Transformation				Alliances for Sales			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	0.043*** (0.009)	0.043*** (0.009)	0.056*** (0.007)	0.056*** (0.007)	0.004 (0.004)	0.004 (0.004)	0.004 (0.003)	0.004 (0.003)
Control Mean	0.015	0.015	0.000	0.000	0.003	0.003	0.001	0.001
Observations	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes	No	Yes	Yes	No

This table reports ordinary least squares estimates of the program's impact. In columns 1 and 3, 5 and 7 of panel a), the effect of the treatment is shown at intermediate and final follow-up (respectively), controlled for fixed effects by community. In columns 2 and 4, 6 and 8, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.6 Impact on Probability of Production and Number of Crops

<i>Panel A: Probability of production</i>							
<i>Agri. Season</i>	Baseline			Follow-up I		Follow-up II	
	(1) Apante	(2) Primera	(3) Postrera	(4) Apante	(5) Apante	(6) Primera	(7) Primera
Treatment = 1	0.005 (0.021)	0.005 (0.021)	-0.027 (0.023)	0.077*** (0.015)	0.075*** (0.015)	0.042** (0.020)	0.038* (0.020)
Control Mean	0.706	0.720	0.372	0.825	0.825	0.728	0.728
<i>Panel B: Number of crops</i>							
<i>Agri. Season</i>	Baseline			Follow-up I		Follow-up II	
	(1) Apante	(2) Primera	(3) Postrera	(4) Apante	(5) Apante	(6) Primera	(7) Primera
Treatment = 1	-0.079 (0.051)	0.167*** (0.060)	-0.036 (0.036)	0.519*** (0.050)	0.537*** (0.050)	0.222*** (0.056)	0.233*** (0.056)
Control Mean	1.291	1.362	0.524	1.421	1.421	1.208	1.208
Observations	1,810	1,810	1,810	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	No	Yes	No	Yes

This table reports ordinary least squares estimates of the program's impact. In columns 1, 2, and 3, the effect of the treatment is shown during the seasons of apante, primera, and postrera at baseline. In columns 4 and 6, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, and finally, in columns 5 and 7, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. Primera marks the main rainy-season sowing; Postrera uses the tail end of the rains; and Apante extends cultivation into the dry months in wetter regions. Together, these three seasons define Nicaragua's agricultural calendar and are essential for analyzing production cycles, yields, and food security outcomes in evaluations like PAIPSAN. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.7 Impact on Maize Production

<i>Panel A: Probability of producing Maize</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	-0.003 (0.023)	0.026 (0.024)	-0.014 (0.021)	0.092*** (0.022)	0.098*** (0.022)	0.035 (0.021)	0.042** (0.021)
Control Mean	0.379	0.489	0.295	0.550	0.550	0.552	0.552
<i>Panel B: Sown area (mz)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.027 (0.045)	0.071 (0.056)	0.158 (0.198)	-0.012 (0.104)	0.021 (0.104)	0.091 (0.070)	0.098 (0.070)
Control Mean	0.518	0.644	0.427	0.825	0.825	0.698	0.698
<i>Panel C: Quantity produced (qq)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.317 (1.220)	0.412 (1.067)	-0.210 (0.981)	5.436*** (2.752)	5.367*** (2.769)	2.265** (0.983)	2.271** (0.990)
Control Mean	12.426	14.427	9.065	9.711	9.711	6.799	6.799
<i>Panel D: Yield (qq/mz)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	-0.061 (0.760)	-2.555 (3.000)	-0.675 (0.709)	8.116** (4.050)	6.941* (4.056)	1.841 (1.860)	1.850 (1.874)
Control Mean	9.918	15.325	7.276	9.169	9.169	7.051	7.051
Observations	1,810	1,810	1,810	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	No	Yes	No	Yes

Estimates are based on ordinary least squares of the program's impact. In columns 1, 2, and 3, the effect of the treatment is shown for the apante, primera, and postrera seasons at baseline. In columns 4 and 6, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, and finally, in columns 5 and 7, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community and household demographic aspects (number of household members, education, gender, and age of the household head) and ethnicity. Primera marks the main rainy-season sowing; Postrera uses the tail end of the rains; and Apante extends cultivation into the dry months in wetter regions. Together, these three seasons define Nicaragua's agricultural calendar and are essential for analyzing production cycles, yields, and food security outcomes in evaluations like PAIPSAN. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.8 Impact on Beans Production

<i>Panel A: Probability of producing Beans</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.021 (0.023)	-0.021 (0.015)	-0.006 (0.017)	0.168*** (0.018)	0.164*** (0.018)	0.032* (0.017)	0.033* (0.017)
Control Mean	0.577	0.127	0.166	0.676	0.676	0.135	0.135
<i>Panel B: Sown area (mz)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.280 (0.280)	-0.021 (0.019)	0.065 (0.048)	-0.424 (0.458)	-0.279 (0.460)	0.023 (0.018)	0.024 (0.018)
Control Mean	0.707	0.117	0.169	1.332	1.332	0.118	0.118
<i>Panel C: Quantity produced (qq)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.487 (1.024)	-0.235 (0.350)	0.208 (0.486)	4.735*** (1.772)	4.474*** (1.778)	0.934* (0.886)	0.952* (0.893)
Control Mean	12.328	2.093	3.024	11.692	11.692	1.301	1.301
<i>Panel D: Yield (qq/mz)</i>							
	Baseline			Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Agri. Season</i>	Apante	Primera	Postrera	Apante	Apante	Primera	Primera
Treatment = 1	0.009 (0.851)	-0.126 (0.454)	-0.045 (0.419)	7.992** (3.840)	7.279* (3.866)	1.253 (1.924)	1.361 (1.940)
Control Mean	11.644	2.626	3.004	12.465	12.465	2.241	2.241
Observations	1,810	1,810	1,810	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	No	Yes	No	Yes

Estimates are based on ordinary least squares of the program's impact. In columns 1, 2, and 3, the effect of the treatment is shown for the apante, primera, and postrera seasons at baseline. In columns 4 and 6, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community, and finally, in columns 5 and 7, the effect of the treatment at intermediate and final follow-up (respectively) is controlled for fixed effects by community and household demographic aspects (number of household members, education, gender, and age of the household head) and ethnicity. Primera marks the main rainy-season sowing; Postrera uses the tail end of the rains; and Apante extends cultivation into the dry months in wetter regions. Together, these three seasons define Nicaragua's agricultural calendar and are essential for analyzing production cycles, yields, and food security outcomes in evaluations like PAIPSAN. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.9 Impact on CSA practices

<i>Panel A: Adoption in agricultural crops</i>				
	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)
Treatment = 1	0.483*** (0.080)	0.476*** (0.081)	0.195*** (0.092)	0.192*** (0.092)
Control Mean	-0.268	-0.268	-0.103	-0.103
<i>Panel B: Adoption in Perennial crops</i>				
	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)
Treatment = 1	0.066 (0.062)	0.063 (0.063)	-0.109 (0.068)	-0.105 (0.069)
Control Mean	-0.033	-0.033	0.043	0.043
Observations	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes

Estimates are based on ordinary least squares of the program's impact. In columns 1 and 3, the effect of the treatment is shown for intermediate and final follow-up (respectively) controlled for fixed effects by community. In columns 2 and 4, the effect of the treatment in the intermediate and final follow-up (respectively) is controlled for fixed effects by community, household demographic aspects (number of household members, education, gender, and age of the household head), and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.10 PAIPSAN Program and Inputs

<i>Panel A: Probability of participating in:</i>										
	<i>Producer cooperatives</i>					<i>Community cooperatives</i>				
	Baseline	Follow-up I		Follow-up II		Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment = 1	-0.000	0.190***	0.192***	0.102***	0.102***	0.061	0.039***	0.030**	0.010	0.001
	(0.008)	(0.017)	(0.018)	(0.018)	(0.018)	(0.019)	(0.016)	(0.016)	(0.014)	(0.014)
Control average	0.029	0.108	0.108	0.232	0.232	0.183	0.110	0.110	0.079	0.079
<i>Panel B: Probability of receiving support in:</i>										
	<i>Inputs (seeds, fertilizers)</i>					<i>Technical Assistance</i>				
	Baseline	Follow-up I		Follow-up II		Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment = 1	0.004	0.246***	0.247***	0.156***	0.158***	0.002	0.009**	0.010**	0.211***	0.213***
	(0.006)	(0.015)	(0.016)	(0.015)	(0.015)	(0.005)	(0.004)	(0.004)	(0.015)	(0.015)
Control average	0.012	0.039	0.039	0.053	0.053	0.011	0.001	0.001	0.037	0.037
	<i>Commercial Support</i>					<i>Technology and Equipment</i>				
	Baseline	Follow-up I		Follow-up II		Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment = 1	0.001	0.166***	0.167***	0.187***	0.188***	0.001	0.029	0.028	0.186***	0.185***
	(0.001)	(0.018)	(0.018)	(0.016)	(0.016)	(0.002)	(0.007)	(0.007)	(0.015)	(0.015)
Control average	0.000	0.151	0.151	0.105	0.105	0.001	0.007	0.007	0.050	0.050
Observations	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	Yes	No	Yes	No	No	Yes	No	Yes

Ordinary least squares (OLS) estimates of the program's impact. Columns (1) and (6), (2) and (7), and (4) and (9) report the treatment effect at baseline, intermediate, and final follow-up (respectively), controlling for community fixed effects. Columns (3) and (8), and (5) and (10) report the treatment effect at the intermediate and final follow-up (respectively), controlling for community fixed effects as well as household demographic characteristics (household size, education, gender, and age of the household head) and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.11 PAIPSAN Program and Subjective Well Being

<i>Panel A: With Harvest</i>					
	Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)
Treatment = 1	0.027 (0.020)	0.138*** (0.021)	0.134*** (0.021)	0.063*** (0.022)	0.061*** (0.022)
Control Mean	0.706	0.600	0.600	0.600	0.616
<i>Panel B: With Food</i>					
	Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)
Treatment = 1	-0.002 (0.017)	0.059*** (0.015)	0.059*** (0.015)	0.054*** (0.013)	0.055*** (0.013)
Control Mean	0.824	0.812	0.812	0.616	0.839
<i>Panel C: With Quality of Life</i>					
	Baseline	Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)
Treatment = 1	-0.002 (0.017)	0.052*** (0.015)	0.053*** (0.015)	0.038*** (0.013)	0.036*** (0.013)
Control Mean	0.823	0.819	0.819	0.839	0.839
Observations	1,678	1,678	1,678	1,678	1,678
Community FE	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	Yes	No	Yes

Ordinary least squares (OLS) estimates of the program's impact. Columns (1), (2), (4), report the treatment effect at baseline, intermediate, and final follow-up (respectively), controlling for community fixed effects. Columns (3) and (5), report the treatment effect at the intermediate and final follow-up (respectively), controlling for community fixed effects as well as household demographic characteristics (household size, education, gender, and age of the household head) and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.

TABLE B.12 PAIPSAN Program and Food Insecurity

	Global Scale				Medium Level of Insecurity (=1)			
	Follow-up I		Follow-up II		Follow-up I		Follow-up II	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment = 1	-0.489** (0.143)	-0.489** (0.142)	0.089 (0.124)	0.072 (0.124)	-0.059** (0.022)	-0.060** (0.022)	0.010 (0.018)	0.005 (0.018)
Control Average	3.292	3.292	1.978	1.978	0.349	0.349	0.205	0.205
Observations	1,619	1,619	1,619	1,619	1,619	1,619	1,619	1,619
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes	No	Yes	Yes	No

Ordinary least squares (OLS) estimates of the program's impact. Columns (1), (3), (5), (7) report the treatment effect at baseline, intermediate, and final follow-up (respectively), controlling for community fixed effects. Columns (2), (4), (6), (8) report the treatment effect at the intermediate and final follow-up (respectively), controlling for community fixed effects as well as household demographic characteristics (household size, education, gender, and age of the household head) and ethnicity. *** Significance at 1%; ** Significance at 5%; * Significance at 10%.