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Learning-Oriented Real-Time Impact Assessment Programme (LORTA)

Impact evaluation report for FP101: Resilient Rural Belize – Backyard Gardens

Executive summary

The *Resilient Rural Belize – Backyard Gardens (BYG)* intervention aims to enhance the resilience of smallholder farmers in Belize by addressing food insecurity, low household income, and vulnerability to climate-related shocks. As part of the broader *Resilient Rural Belize (RRB)* project, the BYG intervention provided beneficiaries with agricultural inputs, including vegetable seeds, tools, small livestock, and technical training. These backyard gardens, situated close to beneficiaries' homes or farmland, were designed to increase food production, improve dietary outcomes, and build economic resilience. This report presents findings from the impact evaluation of the BYG intervention, conducted using a phase-in randomized controlled trial design. Baseline data were collected in 2021, with endline data gathered in early 2024 from 1,350 households (85 per cent coverage).

The evaluation focuses on two key outcomes: changes in household income and food security, and improvements in resilience to climate shocks. The results indicate that the intervention significantly increased household income by an average of 1,371 BZD, driven primarily by gains in crop and livestock-related earnings. Beneficiaries also reported improved resilience to shocks, with reduced asset losses and reliance on external coping mechanisms, such as borrowing or unconditional assistance. However, the impact on dietary diversity was limited, despite increases in protein-rich food consumption. While the intervention shows promising short-term results, the evaluation timeframe of 6–16 months may not fully capture long-term impacts. Future efforts should focus on sustaining and expanding these gains through complementary support, such as nutrition education, improved market access, and longer-term monitoring.

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Abbreviations

ATE	Average treatment effect
BYG	Backyard Garden
BZD	Belize dollar
EQ	Evaluation question
GCF	Green Climate Fund
ha	hectare
ITT	Intention-to-treat
LORTA	Learning-Oriented Real-Time Impact Assessment
NDC	Nationally Determined Contribution
REDD	Reducing emissions from deforestation and forest degradation
RRB	Resilient Rural Belize
UNFCCC	United Nations Framework Convention on Climate Change

Abstract

The *Resilient Rural Belize – Backyard Gardens (BYG)* intervention addresses the dual challenges of food insecurity and smallholder farmers' vulnerability to climate-related shocks. Implemented as part of the broader *Resilient Rural Belize (RRB)* project, the intervention aims to enhance economic, social and environmental resilience by promoting climate-resilient backyard gardens. The project specifically targets poor and vulnerable households, with a focus on women and youth, to foster sustainable agricultural practices, improve household food production, and increase income through better market access.

The BYG intervention supports smallholder households by providing tailored training and agricultural inputs, including seeds, seedlings, tools, small livestock, and technical assistance. These backyard gardens—plots located close to households—are designed to serve as a reliable source of nutritious food while creating income opportunities through surplus production. Beneficiaries were selected based on vulnerability criteria across six districts in Belize, with 2,095 households initially identified as eligible. Of these, 1,595 households were included in the impact evaluation, forming the basis for this assessment. The evaluation employed a phase-in randomized controlled trial design, ensuring a robust methodological framework for measuring the intervention's impact. Eligible households were randomly assigned to treatment (805 households) and control (790 households) groups. The treatment group received BYG support between October 2022 and August 2023, while the control group awaited intervention in a subsequent phase. Baseline data collection occurred in 2021, followed by the endline data collection in January–February 2024, which achieved 85 per cent coverage (1,350 households).

The BYG intervention led to a significant increase in household income. On average, total income rose by 1,372 Belize dollar (BZD), representing a notable improvement over the control group. This growth was primarily driven by increased income from crop production and livestock rearing, highlighting the effectiveness of the agricultural inputs provided. However, no significant changes were observed in agricultural wage income or overall household expenditure. This suggests that while BYG improved income streams, households may not have immediately shifted their spending patterns.

The intervention had a moderate effect on food security and specific components of dietary diversity. While households reported increased consumption of protein-rich foods such as meat and poultry, overall dietary diversity did not improve significantly. The Dietary Diversity Index remained relatively unchanged, indicating that the intervention's focus on vegetable crops and livestock may not have fully translated into a more varied diet. This underscores the need for complementary efforts, such as nutrition education and broader access to diverse food groups, to ensure balanced and sustainable dietary outcomes.

One of the most considerable impacts of the BYG intervention was its role in strengthening household resilience to climate-related shocks. Beneficiaries experienced less severe impacts on income, food production, and asset endowment compared to control households. The Standardized Shock Impact Index showed a positive and significant increase, reflecting households' improved capacity to withstand and recover from shocks such as flooding, crop damage and livestock loss. Furthermore, the intervention reduced reliance on external coping mechanisms, such as borrowing or receiving help from relatives, while helping households preserve long-term agricultural assets. Although beneficiaries were less likely to sell agricultural tools or equipment, they did report increased sales of livestock as a short-term strategy to cope with immediate needs. This suggests that while BYG enhanced resilience, households still required liquidity to navigate unforeseen challenges. The intervention enabled households to adopt better resource management strategies during periods of food scarcity. Beneficiaries were more likely to limit portion sizes and reduce meal frequency,

demonstrating their ability to adapt to shocks. While these strategies reflect ongoing vulnerabilities, they also highlight improved resilience and resourcefulness among project participants.

The BYG intervention has made measurable contributions to enhancing smallholder farmers' economic resilience, food production, and capacity to manage climate-related shocks. The significant improvements in income and resilience outcomes underscore the potential of backyard gardens as a scalable approach to improving livelihoods in vulnerable rural communities. However, the limited impact on dietary diversity points to the need for complementary interventions, such as nutrition education and increased access to a variety of food sources. Looking ahead, sustained monitoring is essential to assess the long-term impacts of the intervention. Given the relatively short evaluation time frame (6–16 months post-implementation), the full benefits of the BYG initiative may not yet be realized. Evaluating agencies are encouraged to continue tracking income stability, food security, and resilience indicators over an extended period. Additional measures, such as strengthening market linkages, diversifying support packages, and addressing gaps in household nutrition, can help ensure the BYG intervention delivers enduring benefits.

I. Context

1. Belize is a small coastal tropical country in Central America, ethnically diverse and classified as an upper-middle-income country. Despite the currently low population density, Belize's population is young and growing rapidly. By 2036, Belize is expected to double its population of 322,453 inhabitants in 2017 (World Health Organization, 2024). In 2021, the population rose to 400,031, representing a 66.4 per cent increase compared to 2000, when the population was around 240,406 inhabitants. Almost half of Belize's population are rural dwellers, and the agricultural sector employs 21.2 per cent of the country's population in 2021 (World Bank Group, n.d.). The average monthly earning of employees in 2021 was estimated at USD 613.9 (International Labour Organization, n.d.). In 2015, 4.3 per cent of the population was identified as being multidimensionally poor, including the three dimensions of health, education, and standard of living. An additional 8.4 per cent was classified as vulnerable to multidimensional poverty (United Nations Development Programme, 2019). In 2022, the working poverty rate was estimated at 11.9 per cent (International Labour Organization, n.d.).

2. From 2002 to 2022, Belize witnessed a loss of 136,000 hectares (ha) of humid primary forest, which accounted for 50 per cent of its total tree cover loss during that period. The overall area of humid primary forest in Belize decreased by 12 per cent within this time frame. Between 2000 and 2020, Belize had a net change of -134 kha (-8.4 per cent) in tree cover. In 2022 alone, the country experienced a loss of 8.17 kha of tree cover, resulting in approximately 4.05 million metric tons of CO_2 emissions (Global Forest Watch, n.d.). The escalating rate of forest and biodiversity loss in Belize exacerbates the existing pressures on ecosystems, including climate change, pollution, environmental degradation, and the continual expansion of farms into forested areas. The country has experienced numerous devastating tropical depressions, storms, and hurricanes, and more recently documented trends of increased droughts, flooding, and significant variation in rainfall patterns. According to the Global Climate Risk Index, Belize ranked 33rd out of 180 countries over the 2000-2019 period (Eckstein, Künzel, and Schäfer, 2021). According to the same study, the average annual losses due to climate-related events are estimated to be USD 96 million (8 per cent of gross domestic product). In addition, the Global Adaptation Index developed by the University of Notre Dame ranked Belize's adaptive capacity at 134th out of 182 countries (University of Notre Dame, 2024). Smallholder farmers are particularly vulnerable as they suffer severe losses from extreme climate events and through the impacts of persistent and unpredictable seasonal variations such as rainfall and increased temperature.

3. The implications of increased climate stressors will pose major consequences on vulnerable populations. First, the increase in hurricane frequency and intensity is likely to damage large infrastructure and reduce production and yields, as well as accessibility to markets and basic services. Second, the increased rainfall variability can increase the frequency and duration of droughts and floods, ultimately affecting land erosion. In addition, the temperature increase can affect humidity levels even more, increasing the severity of droughts (Caribbean Community Climate Change Centre, 2014). Furthermore, it will create conditions for pests and diseases to proliferate. Finally, sea level rises can affect flood frequency and cause more damage to infrastructure. Consequently, the country will rely more on food imports that can be supplied competitively by smallholders in Belize if climate change adaptation succeeds (Green Climate Fund, 2019).

Policy context

4. Belize's contributions to global greenhouse gas emissions are relatively minor, and the country's capacity to mitigate global climate change is limited. Nevertheless, Belize is committed to contributing to limiting the increase in global average temperature and to developing a long-term strategy aligned with achieving net zero global emissions by 2050. This commitment is guided by Belize's Nationally Determined Contribution (NDC), which was first submitted in 2016 and updated ahead of the 26th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in 2021. The implementation will be coordinated by the Belize National Climate

Change Office with advice from the Belize National Climate Change Committee. To monitor the annual progress of mitigation and adaptation actions, the NDC implementation plan will be accompanied by a series of evaluation systems.

5. Belize has made considerable progress in conserving its coastal habitats since the 2016 NDC. Key initiatives include the endorsement of an Integrated Coastal Zone Management Plan, which incorporates ecosystem services and risk analysis into decision-making. The 2018 Forests (Protection of Mangroves) Regulations introduced a permitting system to safeguard mangroves from deforestation. Efforts are also under way to protect critical water catchment areas and forests through the draft National Land Use Policy. The National Biodiversity Strategy and Action Plan aims to enhance Belize's natural environment within the coastal zone.

6. In 2020, the Blue Carbon Working Group was formed to assess the blue carbon potential and adaptation co-benefits of coastal ecosystems. This group consists of representatives from various sectors and will inform targets and recommendations for long-term protection and management. These recommendations will be integrated into existing policies and plans, such as the Integrated Coastal Zone Management Plan, the National Biodiversity Strategy and Action Plan, the National Climate Change Policy Strategy and Action Plan, and the Forests (Protection of Mangroves) Regulations. In 2021, Belize refinanced USD 533 million of debt (equivalent to 40 per cent of gross domestic product) through a Belize Blue Bond in a large-scale, market-based debt buy-back involving the Nature Conservancy, Credit Suisse, as well as the International Finance Corporation, the private sector arm of the World Bank.

7. Belize has established the Climate Finance Working Group to guide efforts in accessing and effectively utilizing climate finance. The government has increased public capital investment in climate change resilience. Belize has successfully accessed climate finance from various funds under the UNFCCC, including the Global Environment Facility, Adaptation Fund, Special Climate Change Fund and Green Climate Fund (GCF). The Belize Protected Areas Conservation Trust serves as the national implementing entity for the Adaptation Fund and the first nationally accredited entity for GCF, enhancing the country's capacity to access climate finance. Belize is actively pursuing its REDD+[1] strategy, National Forest Monitoring System, Forest Reference Level, and Safeguards Information System to achieve results-based payments under the UN REDD+ platform. The REDD+ Strategy was finalized in 2021, with continuous improvements to the National Forest Monitoring System. The Forest Reference Level has been assessed by the UNFCCC, and the Safeguards Information System is nearing completion. Belize also plans to pursue results-based payments for the current and future Forest Reference Levels (United Nations Framework Convention on Climate Change, 2021).

8. To ensure food and nutrition security, increase farmers' income, generate employment, and attract private sector investment and involvement in the sector, Belize formulated the National Agriculture and Food Policy, which spans 15 years from 2015 to 2030. The policy is structured around five pillars: (i) enhancing production, productivity and competitiveness, (ii) facilitating market development and access, (iii) promoting food and nutrition security and rural livelihoods, (iv) encouraging sustainable agriculture and risk management, and (v) improving governance. To address food and nutrition security, the policy aims to reduce malnutrition by promoting the "produce local, buy local, eat local" campaign, increasing the availability of safe, nutritious and locally produced food commodities. Strategies will focus on improving diets and preventing malnutrition, particularly among vulnerable and impoverished populations. Nutrition education will be provided in schools and communities, and a special programme for backyard and school gardening will be developed to enhance food availability at the household and school levels.

9. Diversifying sustainable livelihood options is another priority, ensuring food and nutrition security for all. Small-scale producers shall be encouraged to enter specialized markets, while farmers'

[1] REDD refers to reducing emissions from deforestation and forest degradation.

organizations will be promoted to help small-scale family farmers access financial, processing and business services. The policy also emphasizes engaging youth in agribusiness to ensure the sector's continuity. To ensure sustainable production, productivity and competitiveness, the policy will strengthen investment incentives for the agriculture and food sectors. Quality criteria and sanitary and phytosanitary requirements for domestic and international trade will be met through established mechanisms. Agricultural education and training will be enhanced to boost productivity, and research and development will facilitate the adoption of innovative technologies for competitiveness. Infrastructure improvements will support increased production, and efforts will be made to address constraints in the enabling environment, improving access to domestic and external markets. This includes improving market information systems, utilizing innovative marketing, and strengthening linkages between the agriculture, tourism and manufacturing sectors. An efficient information and communication system will be developed. The policy also integrates climate change adaptation, disaster risk reduction and management into the agriculture and food sectors. Support will be provided for adaptation and mitigation strategies, and the policy framework and institutional capacity will be strengthened to promote integrated environmental management. Strategies to combat praedial larceny (theft of agricultural produce) and contraband will also be implemented.

10. The government in Belize places great emphasis on national extension to deliver services, especially to smallholder farmers. Agricultural extension services are usually delivered through the Department of Agriculture, a division of the Ministry of Agriculture, Fisheries, Forestry, Environment, Sustainable Development and Immigration. Extension services are expected to provide knowledge and innovations through working alongside smallholders, including integrating local and indigenous approaches to adapting to environmental change (Drexler, 2021).

II. Project intervention

11. The overall goal of the RRB project is to increase farmers' resilience and adaptation to climate change. It aims to increase farmers' economic, social, and environmental resilience by introducing climate-resilient agricultural practices that allow smallholders to achieve sustainable production and improve their market access, even under climate stress. Furthermore, RRB supports the development of value chains for smallholder farmers that are resilient and adapted to the effects of climate change and aim at strengthening producer organizations. Lastly, the project envisions upgrading public infrastructure such as roads, drainage and information systems to improve market access. The initial target population is poor and vulnerable smallholder farmers in 23 communities clustered in all districts of Belize. The scope of the project is to affect up to 29 per cent of the country's population, either directly or indirectly. The International Fund for Agricultural Development of the United Nations is the accredited agency for the project. The RRB project is managed by a project management unit, which is hosted by the Belize Ministry of Agriculture, Food Security and Enterprise, while the Ministry of Finance, Economic Development and Investment serves as the lead agency. RRB is co-funded by the International Fund for Agricultural Development and the GCF.

12. The project prioritizes strengthening the resilience of smallholder households, particularly through climate-resilient agricultural practices. Given the vulnerability of rural households to climate shocks and economic disruptions, the BYG intervention was introduced as a targeted strategy to improve food security, boost incomes and build resilience at the household level. The BYG intervention promotes small-scale gardens, i.e., plots close to beneficiaries' homes (between ⅛ and ¼ acre) or on their farmland, as a cost-effective and accessible solution. By providing training, technical assistance and inputs such as garden tools, materials, small livestock, vegetable seeds, and seedlings, the project aims to empower beneficiaries with the resources needed to sustain production and mitigate food insecurity. Beneficiaries received a tailored package valued at USD 150, which included inputs chosen based on their individual needs. Training sessions were customized for each package, focusing on areas like vegetable production, poultry care, or pig nutrition and management. While additional details regarding training and support packages are provided in the following sections and Appendix 1, this overview highlights the intervention's role in fostering self-sufficiency and climate resilience among vulnerable rural communities.

13. The intervention prioritized the inclusion of youth and women, targeting poor or vulnerable households that are at high risk of falling below the poverty line due to climate or economic shocks. Further details on the selection criteria can be found in Appendix 1. After the identification process, about 2,095 prospective beneficiaries from the five priority districts were targeted by the project to increase households' ability to cope with climate change. The beneficiaries were identified in 13 priority communities grouped in four clusters: two communities in Orange Walk District (San Felipe and Santa Marta), five in Belize District (Bomba, Boston, Maskall, Rockstone Pond and Santana), three in Cayo District (Valley of Peace, San Antonio and Seven Miles), and three in Toledo District (Trio, Bella Vista and San Isidro). Beneficiaries have also been identified in non-priority areas, constituting 54 communities in all six districts. A list of all communities can be found in Appendix 1.

Theory of change

14. The BYG component aims to strengthen the resilience of smallholder households in Belize to climate-related shocks. The overarching goal is to improve food security, increase income, and enhance the overall resilience of these households against the adverse effects of climate change.

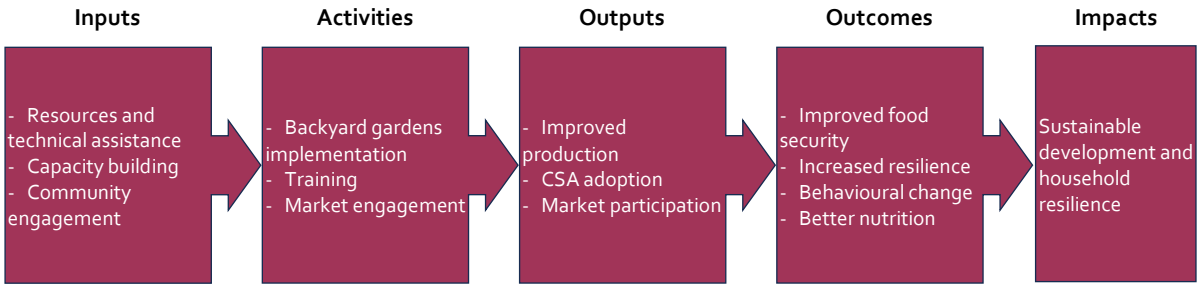
15. Figure 1 visualizes the BYG component's theory of change: each household receives a package of inputs consisting of seeds, seedlings, small livestock, garden tools, and materials necessary to establish and maintain a productive backyard garden, depending on the specific type of support selected by the beneficiary.

16. The implementation of backyard gardens is central to the project component's activities. Households are supported in establishing their gardens, with continuous monitoring and assistance to ensure effective garden management. Training sessions were conducted upon the distribution of inputs to reinforce learning and address any challenges that might arise. As a result of these activities, households were expected to adopt climate-resilient agricultural practices that improve the quality and volume of produce in their backyard gardens. This, in turn, was expected to lead to greater food security, with households having a reliable source of nutritious food that reduces their dependence on external food sources, especially during times of climate-related disruptions. Moreover, the project aimed to increase market participation among beneficiaries, leading to higher household income from the sale of surplus produce.

17. The BYG component is expected to have diverse outcomes, including increased resilience to climate shocks, diversified and sustainable food sources, and enhanced capacity to withstand and recover from adverse events. Additionally, households are anticipated to experience improved financial stability by increasing savings and reducing their reliance on credit. Furthermore, the project aims to foster long-term behavioural changes, making sustainable agricultural practices a regular part of household routines, and contributing to both environmental sustainability and household resilience. In the long term, the BYG component is expected to strengthen the resilience of smallholder households in Belize. By fostering a robust and climate-resilient agricultural community, the project will enable households to sustain their livelihoods despite the challenges posed by climate change. Furthermore, the project contributes to broader national goals of sustainable development by reducing poverty, enhancing food security and promoting environmental stewardship.

18. The success of the BYG component rests on several key assumptions: (i) beneficiaries are motivated to adopt and maintain backyard gardens, (ii) the technical assistance and resources provided are adequate and appropriate, (ii) market access is sufficient to absorb the increased production, and (iv) the infrastructure and environmental conditions support the successful implementation of the gardens.

Figure 1: Backyard Garden theory of change



Abbreviation: CSA stands for climate-smart agriculture.

III. Data collection

3.1. Endline data collection

19. Between August and September 2021, an intake form that collected baseline information on the 1,595 households was included in the impact evaluation. The form captured basic characteristics, including general demographic, social, and economic characteristics of the applicant's household. Households were randomly assigned to treatment and control groups considering their characteristics (such as age, gender composition or geographical location) before treatment started, i.e., at baseline.

20. The endline data collection took place in January and February 2024 and was carried out by a consulting firm (praxi5 Advisory Group Ltd.). The sampling strategy for the endline data collection aimed to trace and interview all the 1,595 eligible households that were identified during the baseline stage. The firm was able to track and interview 1,350 households, with overall coverage of 85 per cent of the 1,595 households from the baseline. The endline data collection captured information that was crucial to answering key evaluation questions, ranging from income and changes in diet to coping strategies and assets.

3.2. Challenges encountered during data collection

21. The data collection experienced certain challenges during the endline phase. In late January, inclement weather conditions slowed the administration of the surveys in some districts. Due to the travelling distance from the home locations of enumerators to some of the surveyed communities, the submission of completed surveys was delayed. Several BYG beneficiaries could not be interviewed due to migration, inconsistency in the location and address and working outside of the communities during the survey administration.

IV. Evaluation strategy

4.1. Questions and indicators

22. The evaluation of the BYG component addresses several research questions to assess the effectiveness and impact of the intervention using endline data. Developed collaboratively by the LORTA team and the RRB team, the evaluation revolves around two key evaluation questions (EQs) that are crucial for understanding the broader impacts of the BYG intervention on households in Belize. These evaluation questions form a comprehensive framework for assessing the impact of BYG on the economic and nutritional well-being of households, as well as their capacity to build resilience against adverse events. By measuring these key indicators, the impact evaluation aims to generate robust evidence on the effectiveness of the BYG component, providing insights for future interventions and policy decisions to enhance the resilience and livelihoods of rural households in Belize.

EQ1: Changes in healthy diet and household income

23. One of the primary goals of the BYG intervention is its potential to improve the dietary habits and income levels of beneficiary households. This evaluation question aims to investigate whether the BYG has led to tangible changes in household diets and income. To answer this question, the impact evaluation focuses on two main indicators:

- **Changes in diet**: The impact on diet is measured using the **Dietary Diversity Index**, which captures the variety of food groups consumed by a household over a specific period. An increase in dietary diversity is often correlated with improved nutritional intake and overall health. The evaluation will assess whether households participating in the BYG project experience greater dietary diversity, indicating a shift towards healthier eating habits.
- **Income**: The evaluation examines changes in household income, a critical factor in determining the overall economic resilience and well-being of households. Household income is measured as the sum of various income-generating activities, crop income, crop sales, livestock income and agricultural wage income. The analysis assesses whether the BYG initiative has led to significant improvements in the income levels of beneficiary households, which in turn could enhance their ability to access a healthy diet and other essential services. Additionally, household expenditure is considered as an additional, separate indicator to indicate changes in household income.

EQ2: Increase in household resilience

24. The second evaluation question aims to determine whether the BYG intervention has successfully increased the resilience of households to climate-related shocks and other adverse events. Resilience, in this context, refers to the ability of households to cope with and recover from shocks, thereby maintaining or improving their overall well-being. To answer this EQ, the following indicators are used:

- **Assets**: Household resilience is partly assessed through the ownership of assets, including appliances and equipment, as well as the condition of housing. An increase in the accumulation of assets and improvements in housing conditions are indicators of greater economic stability and resilience. The evaluation explores whether BYG participants have experienced positive changes in their asset base as a result of the project.
- **Food consumption and climate resilience**: Another critical aspect of resilience is the ability to maintain healthy food consumption patterns even in the face of shocks. The evaluation measures this through an **Adjusted Coping Strategy Index** and other metrics such as the number and type of shocks experienced by households, and the consequences of these shocks. Specific questions were posed to households, asking them how their income, assets, food

production, food stocks, and food purchases have been affected by shocks over the past 12 months. The responses help to determine whether the BYG initiative has enhanced the ability of households to withstand and recover from such events, thereby contributing to greater overall resilience.

4.2. Methodological approach

25. The evaluation of the BYG component employs a phase-in randomized controlled trial. Randomization is a core technique in impact evaluation that ensures the treatment and control groups are statistically equivalent at baseline. By randomly assigning units to either group, this method helps eliminate confounding factors, making it possible to attribute differences in outcomes to the intervention itself.

26. In the case of the BYG, the intervention targeted poor and vulnerable smallholder farmers across various districts in Belize, and the randomization process was conducted at the household level.

    (a) First, eligible households were identified based on predefined criteria as described in section II, such as their vulnerability to climate shocks and economic status. Further details on the selection criteria can be found in Appendix 1. As described above, these households were drawn from priority communities within several districts, ensuring a representative sample that could provide insights into the effectiveness of the BYG intervention. A list of all communities can be found in Appendix 1.

    (b) The design follows a phase-in randomized controlled trial approach, where all eligible participants eventually receive the intervention, but the timing is randomized. In this context, the phase-in design allowed for rigorous impact evaluation while ensuring that all households eventually benefited from the intervention, addressing ethical concerns about withholding treatment from vulnerable populations. Random assignment was conducted using statistical software to ensure fairness and eliminate biases in the process. After identifying the eligible households, they were randomly assigned to either the treatment group or the control group. Out of the 2,095 prospective beneficiaries identified as eligible for the project through this process, 500 beneficiaries were already selected for treatment in a non-random manner. The evaluation thus includes only the remaining 1,595 households, of whom 805 were randomized into the treatment and 790 were randomized into the control group. The treatment group received inputs such as seeds, seedlings, small livestock, garden tools and technical assistance provided through the BYG project. The majority of the treatment group received the intervention between October 2022 and August 2023 although some of the beneficiaries received their inputs between October and December 2023. The control group did not receive these resources during this period, but they would receive the same intervention in the second phase.

27. Following the implementation of randomization, the evaluation of the BYG component's impact involves several estimation techniques, focusing on the **average treatment effect (ATE)** and **intention-to-treat (ITT) analysis**. These techniques help to assess the effectiveness of the intervention under different conditions of compliance and provide a robust understanding of its impact on the targeted households. The combination of careful randomization and appropriate estimation techniques ensures that the impact evaluation provides reliable, valid and actionable insights into the effectiveness of the BYG component in enhancing the resilience and economic well-being of smallholder farmers in Belize.

28. The evaluation focuses on estimating the ATE, which represents the average impact of the intervention on the entire target population. This provides a comprehensive understanding of how the intervention affects the general population, assuming universal compliance with the treatment. The ATE is estimated using the following regression model:

$$y_i = \alpha + \beta' Treat_i + X'\gamma + \varepsilon_i \quad (1)$$

where y_i is the outcome for household i (such as a food security indicator or proxy for income), $Treat_i$ is an indicator for being in the treatment group, and β is the average treatment effect. X represents a vector of control variables such as age, sex, cultivated area, and other sociodemographic characteristics (education level, wealth, migration behaviour, housing quality). Since the sample design would be based on randomized selection of treatment and control groups, it provides a sound basis for making causal inferences from the collected data.

29. In the case of **imperfect compliance**, i.e., where households assigned to the treatment group do not fully adhere to the intervention or where control group households inadvertently receive the treatment, the specification will estimate the ITT effect. The ITT analysis provides a more conservative estimate by comparing outcomes based on original treatment assignment, regardless of actual treatment received. The ITT effect is estimated using the same regression framework as ATE, but it measures the impact of being assigned to the treatment rather than the impact of receiving the treatment.

V. Evaluation results

5.1. Sample description

Sociodemographic characteristics of the sample

30. Table 1 shows that the baseline characteristics[2] of the sample households reveal a balanced distribution between treatment and control groups across key demographic, educational, and socioeconomic indicators. This largely balanced sample provides a strong foundation for evaluating the impact of the BYG component on household resilience, food security and income.

31. The households are evenly distributed within the six key districts involved in the project. The districts of Belize and Cayo account for about 9 per cent and 19 per cent of the sample, respectively, with Corozal and Orange Walk representing approximately 14 per cent and 10 per cent. Stann Creek has the highest representation at around 27 per cent, followed by Toledo at 20 per cent. These percentages are consistent between the treatment and control groups, indicating a balanced geographic distribution.

32. Approximately 80 per cent of the household heads are married, with no significant difference between treatment and control groups. The average age of household heads at baseline was around 39 years, and the sample is predominantly composed of male-headed households, with about 78 per cent of heads being male across both groups. In terms of education, around 7 per cent of household heads had no formal education at baseline, while roughly 63 per cent had completed primary school, and about 12 per cent had completed secondary education. Baseline literacy rates are high, with around 85 per cent of household heads being literate, and language skills are evenly distributed, with about 55 per cent reading Spanish and 75 per cent reading English.

33. The composition of households is similarly balanced between treatment and control groups. The average household size at baseline is about 4.7 members, with each household typically having one adult male and one adult female. Youth composition at baseline is also similar, with around 0.5 youth males and 0.5 youth females on average. Access to basic amenities was widespread, with approximately 88 per cent of households having had piped water, 17 per cent having had flush toilets, and 85 per cent having had electricity. Around 37 per cent of households reported having a backyard garden, evenly distributed across both groups.

34. When examining household income, the distribution across income categories is also fairly uniform. Approximately 19 per cent of households earned less than BZD 300 per month, while around 39 per cent fell into the next income bracket (up to BZD 499). Only about 2.5 per cent of households had incomes up to BZD 1,499, and less than 1 per cent reported earnings above BZD 1,500. These figures are consistent across treatment and control groups, with no statistically significant income differences between them. There are no significant differences between the treatment and control groups regarding land access. About 75 per cent of households had access to less than a quarter acre of land at baseline, and roughly 11 per cent had access to less than half an acre. Less than 1 per cent had access to one to five acres.

[2] Obtained from the data collected through the intake in 2021, before the intervention was implemented. As randomization was conducted at baseline, we present baseline characteristics to ensure the sample is balanced.

Table 1: Summary statistics on sample descriptive

	Treatment			
	No	**Yes**	**Total**	**Test**
N	660 (49.0%)	687 (51.0%)	1,347 (100.0%)	
Belize	0.089 (0.286)	0.092 (0.289)	0.091 (0.287)	0.883
Cayo	0.186 (0.390)	0.195 (0.397)	0.191 (0.393)	0.685
Corozal	0.138 (0.345)	0.144 (0.351)	0.141 (0.348)	0.743
Orange Walk	0.108 (0.310)	0.103 (0.305)	0.105 (0.307)	0.801
Stann Creek	0.273 (0.446)	0.266 (0.442)	0.269 (0.444)	0.793
Toledo	0.205 (0.404)	0.199 (0.400)	0.202 (0.402)	0.815
Characteristics of the household head at baseline				
Marital status (0=unmarried, 1=married)	0.808 (0.394)	0.799 (0.401)	0.803 (0.398)	0.666
Age of household head	39.356 (13.949)	38.717 (13.824)	39.032 (13.884)	0.401
Share of female-headed households	0.779 (0.415)	0.774 (0.419)	0.776 (0.417)	0.805
No formal education	0.080 (0.272)	0.066 (0.248)	0.073 (0.260)	0.296
Completed primary	0.647 (0.478)	0.610 (0.488)	0.628 (0.484)	0.160
Completed secondary	0.111 (0.314)	0.119 (0.324)	0.115 (0.319)	0.615
Literacy	0.842 (0.365)	0.860 (0.347)	0.851 (0.356)	0.352
Reads Spanish	0.553 (0.498)	0.562 (0.496)	0.558 (0.497)	0.714
Reads English	0.753 (0.431)	0.759 (0.428)	0.756 (0.430)	0.815
Writes Spanish	0.527 (0.500)	0.530 (0.499)	0.528 (0.499)	0.909
Writes English	0.734 (0.442)	0.741 (0.438)	0.737 (0.440)	0.758
Household composition at baseline				
Household size	4.796 (1.949)	4.670 (1.932)	4.739 (1.941)	0.264
Number of adult males in the hh*	0.977 (0.548)	0.976 (0.556)	0.977 (0.551)	0.976
Number of adult females in the hh	1.021 (0.543)	0.996 (0.525)	1.010 (0.535)	0.420
Number of male youths	0.490 (0.783)	0.588 (0.755)	0.507 (0.779)	0.181
Number of female youths	0.458 (0.697)	0.505 (0.717)	0.480 (0.707)	0.247
Has piped water	0.878 (0.327)	0.894 (0.308)	0.886 (0.317)	0.355
Has flush toilet	0.166 (0.372)	0.177 (0.382)	0.172 (0.377)	0.589
Has electricity	0.840 (0.367)	0.851 (0.356)	0.846 (0.361)	0.579
Has backyard garden	0.382 (0.486)	0.368 (0.482)	0.375 (0.484)	0.586
Household income at baseline (in BZD)				

	Treatment			
	No	**Yes**	**Total**	**Test**
Less than 300	0.207 (0.405)	0.169 (0.375)	0.188 (0.390)	0.073
Up to 499	0.365 (0.482)	0.413 (0.493)	0.389 (0.488)	0.076
Up to 1,499	0.018 (0.134)	0.031 (0.174)	0.025 (0.155)	0.133
More than 1,500	0.002 (0.039)	0.004 (0.067)	0.003 (0.055)	0.331
Land size in acres at baseline				
Less than a quarter	0.760 (0.428)	0.746 (0.436)	0.752 (0.432)	0.556
Less than half	0.111 (0.315)	0.104 (0.305)	0.107 (0.310)	0.656
Less than one	0.003 (0.055)	0.010 (0.101)	0.007 (0.082)	0.103
One to five	0.003 (0.055)	0.009 (0.094)	0.006 (0.077)	0.168

Source: Authors' calculations based on survey data.
Note: *hh stands for "household". Standard errors are presented in parentheses.

35. Overall, the baseline data indicate that the randomization process successfully created two comparable groups, with no significant differences between treatment and control households in terms of demographic composition, education, income levels, and access to resources. This balance strengthens the reliability of the evaluation by ensuring that any observed differences in outcomes are likely attributable to the intervention itself. Table 6 displays household characteristics at endline and demonstrates that the balance achieved at baseline across treatment and control groups was largely maintained. Household characteristics, such as marital status of the head, education levels, and basic amenities, remain consistent between groups, with no significant differences in most demographic, educational, and socioeconomic indicators. Minor differences emerged in certain variables, such as the number of school-aged children (aged 5–17) and the number of household members attending school, with slightly lower averages in the treatment group, as well as a small difference in household composition regarding the number of men and boys. Additionally, there is a notable difference in the average land area for crop cultivation, which increased more in the treatment group, possibly reflecting the impact of the intervention. These variables are included in the impact estimates to control for the slight imbalance between the two groups at endline.

5.2. EQ1: Changes in healthy diet and household income

36. The EQ1 seeks to assess the impact of the BYG intervention on a healthy diet and household income among the target population. Table 2 summarizes the impact of an intervention on various aspects of household income and expenditure.

37. Total household income was significantly increased by BZD 1,371.59 ($p < 0.05$), compared to the control mean of BZD 5,461. This suggests that the intervention had a notable positive impact on overall household income. Total crop income and total livestock income were also positively affected through the BYG intervention, increasing by BZD 142.29 and BZD 18.35 among beneficiaries compared to the control group, respectively.

38. In contrast, we did not observe any significant impact on total agricultural wage income or overall household expenditure. The lack of significant impact suggests that the intervention did not notably influence household spending patterns.

Table 2: Impact on income and expenditures

EQ1 – Income	Impact		Control mean	Observations
Total household income (in BZD)	1,371.59 (637.22)	**	5,461	1,346
Total crop income (in BZD)	142.29 (70.12)	**	298.57	1,346
Total livestock income (in BZD)	18.35 (19.93)		106.27	1,346
Total agricultural wage income (in BZD)	235.64 (281.45)		990.11	1,346
Total household expenditure (in BZD)	-18.00 (34.31)		1,210	1,346

Source: Authors' calculations based on survey data.
Notes: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level respectively. Impacts represent the effects from OLS or probit regression, depending on the nature (continuous or binary) of the indicator. Standard errors are presented in parentheses and clustered at the village level. The control mean represents the mean indicator value of untreated household.

39. Table 3 outlines the impact of an intervention on various aspects of household food consumption and dietary diversity. The results are presented as percentage changes and indicate how the intervention affected specific food groups and overall dietary diversity. The intervention had a small negative effect on the experience of insufficient food or money to buy food. However, this change is not statistically significant, meaning the intervention did not have a reliable impact on reducing food insecurity.

40. The intervention had mixed effects on household food consumption and dietary diversity. The Standardized Dietary Diversity Index (DDI) captures the variety of foods consumed by a household over the seven days preceding the survey. It is constructed from the reported frequency of consumption (0–7 days) across multiple food groups[3]. For each food group, the frequency is standardised to the sample mean and standard deviation, and the resulting z-scores are averaged to create the index. Higher values indicate greater dietary diversity relative to the sample average. Results show a small and statistically insignificant decrease of 0.01 standard deviations in the DDI for BYG beneficiaries compared to the control group, suggesting no meaningful change in overall dietary diversity. However, disaggregated analysis shows a statistically significant increase in the consumption of meat, poultry, and offal, indicating improved access to protein-rich foods, alongside reductions in condiment and non-water beverage consumption. These changes in specific food groups point to shifts in diet composition even if the overall diversity score remained unchanged.

[3] Cereals; roots and tubers; pulses, legumes, and nuts; vegetables; fruits; meat, poultry, and offal; eggs; fish and seafood; dairy products; sugar and honey; oils and fats; condiments; and beverages other than water.

Table 3: Impact on dietary diversity and food consumption

EQ1 – Food	Impact		Control mean	Observations
Insufficient amount of food/money to buy food	-0.12 (0.09)		0.42	1,331
Standardized Dietary Diversity Index	-0.01 (0.04)		0.01	1,345
Meat, poultry, offal	0.27 (0.14)	*	4.08	1,343
Eggs	-0.20 (0.14)		5.01	1,344
Fish and seafood	-0.09 (0.08)		1.19	1,344
Milk, yoghurt and other dairy products	0.17 (0.16)		3.92	1,344
Sugar and sugar products, honey	0.12 (0.19)		5.94	1,344
Oil, fats and butter	-0.04 (0.11)		5.99	1,342
Condiments	-0.21 (0.10)	**	6.25	1,343
Beverages (not water)	-0.18 (0.10)	*	6.27	1,342

Source: Authors' calculations based on survey data.
Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level respectively.
Impacts represent the effects from OLS or probit regression, depending on the nature (continuous or binary) of the indicator. Standard errors are presented in parentheses and clustered at the village level. The control mean represents the mean indicator value of untreated household.

5.3. EQ2: Increase in household resilience

41. The BYG intervention has shown statistically significant positive impacts on several key indicators of household resilience. The intervention effectively increased households' capacity to withstand and adapt to shocks by improving asset endowment, income stability, food production, and coping strategies. These outcomes are crucial for enhancing the overall resilience of smallholder households in Belize, enabling them to better manage and recover from the adverse effects of climate change.

42. The intervention significantly increased the households' ability to withstand and manage the effects of shocks. The positive and significant impact on the Standardized Shock Impact Index indicates that households supported through the BYG intervention were better equipped to cope with adverse climate-related events, reflecting enhanced resilience. This finding underscores the effectiveness of the BYG initiative in building resilience against environmental and economic shocks. Investigating the individual components of the standardized shock impact score, BYG beneficiaries report significantly less severe effects on several aspects combined in the index. The negative control mean

of the index, as well as the negative control mean for individual components, indicates that among the households that did not receive any support from the project yet, food security, income, and asset endowment were negatively affected.[4] Results show a significant positive impact on changes in asset endowment following shocks among participating households, suggesting that the support provided through the BYG project helped households to better maintain their asset base, which is crucial for economic stability and resilience. This reflects the project's success in providing resources that contribute to long-term resilience. While the negative impact of shocks on asset endowment among beneficiaries is mitigated through the intervention, overall asset endowment remains unaffected by the intervention.

43. The intervention also had a positive impact on the changes in household income, mitigating income loss in the face of different challenges. Maintaining income levels is critical for ensuring household resilience, as it enhances the ability of households to access essential goods and services, thereby reducing their vulnerability to shocks. The BYG intervention positively affected the consequences on food production, helping households maintain their agricultural output despite experiencing different shocks. This outcome is vital for ensuring food security, as it provides households with a reliable source of food, reducing dependence on external food supplies during times of disruption.

44. The Standardized Coping Strategy Index (CSI) measures the relative frequency of five food-related coping behaviours[5]. The index is calculated only for households that reported insufficient food or money to buy food in the past seven days (about 40 % of the sample). For each household, the frequency of each coping strategy (0–7 days) is standardised to the sample mean and standard deviation, and the resulting z-scores are averaged to form the CSI. Higher values indicate more frequent use of coping behaviours within this food-insecure subgroup. Results show a statistically significant increase of 0.13 standard deviations among BYG beneficiaries compared to the control group. Disaggregated results reveal that the only individual coping behaviour with a statistically significant difference is limiting portion sizes, which beneficiaries reported more often. This may reflect hardship but can also be interpreted as a form of adaptive adjustment to scarce resources. As the CSI captures behaviours only among households already experiencing food insecurity, and may be affected by seasonal factors and interview timing, these results should be viewed as indicative rather than as a general measure of resilience for the full sample.

Table 4: Impact on resilience

EQ2 – Resilience	Impact		Control mean	Observation
Standardized Shock Impact Index	0.14 (0.05)	***	-0.07	902
As the result of the shock(s) that affected your households in the past 12 months, did your				
Asset endowment change	0.11 (0.04)	***	-0.60	900
Income change	0.08 (0.03)	**	-0.77	902

[4] Respondents were asked if their asset endowment, income, or food-related aspects were impacted as a result of the shock(s) that affected their households in the past 12 months. Responses were coded as follows: -1 Decreased, 0 Unchanged, 1 Increased. While a positive impact on these indicators does not necessarily indicate that the aspect in question, e.g., income, increased as a result of the experienced shock, it indicates that the negative impact on treated households was less severe.

[5] Relying on less preferred foods, seeking help from relatives or friends, limiting portion sizes, restricting adult consumption, and reducing the number of meals.

EQ2 – Resilience	Impact		Control mean	Observation
Food production change	0.07 (0.03)	**	-0.75	900
Food purchases change	0.03 (0.03)		-0.77	899
Food stock change	0.03 (0.03)		-0.81	901
Coping strategies				
Standardized Coping Strategy Index	0.13 (0.07)	**	-0.07	530
Rely on less preferred and less expensive foods	-0.16 (0.22)		0.97	530
Rely on help from a friend or relative	0.10 (0.11)		1.52	530
Limit portion size	0.28 (0.15)	***	0.57	530
Restrict consumption by adults	0.04 (0.12)		1.20	530
Reduce the number of meals	0.20 (0.13)		0.69	530
Assets				
Aggregate asset score	-0.01 (0.01)		0.40	1,335
Agricultural asset score	-0.03 (0.02)		0.40	1,259
Aggregate communication score	0.00 (0.03)		0.59	1,335
Aggregate energy score	0.00 (0.01)		0.35	1,335
Aggregate transport score	-0.02 (0.01)		0.27	1,335

Source: Authors' calculations based on survey data.
Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level respectively.
Impacts represent the effects from OLS or probit regression, depending on the nature (continuous or binary) of the indicator. Standard errors are presented in parentheses and clustered at the village level. The control mean represents the mean indicator value of untreated household.

45. Table 5 presents the results of an analysis examining the effectiveness of various coping strategies employed by households in response to shocks. These strategies are critical for understanding how households manage risks and maintain resilience in the face of economic or environmental stressors. The table specifically highlights the statistically significant impacts of the BYG intervention on different shock response strategies. The intervention significantly reduced the likelihood of households receiving unconditional help from relatives or friends by 26 pp. This decrease suggests that households involved in the intervention may have become more self-reliant or better equipped to handle shocks without needing external assistance from their social networks. Additionally, the BYG support led to a significant reduction in the likelihood of households obtaining credit by 38 pp compared to the control group. This result implies that participating households were less dependent on borrowing to cope with shocks, possibly due to improved financial stability or resilience provided by the intervention.

46. BYG beneficiaries are also 50 pp less likely to sell agricultural assets compared to the control group, suggesting that the intervention successfully helped households maintain their agricultural assets, which are crucial for long-term resilience and livelihood sustainability. By reducing the need to sell these assets, the intervention likely contributed to the preservation of households' productive capacity. Interestingly, the intervention led to a 27 pp increase in the likelihood of households selling livestock. This outcome indicates that while households were less likely to sell long-term agricultural assets, they were more willing or perhaps better positioned to sell livestock as a more immediate response to shocks. This may reflect a strategic choice to manage liquidity or meet urgent needs without compromising other critical assets, but the finding is also consistent with most beneficiaries having received livestock such as poultry through the BYG project.

47. The results indicate that the BYG intervention had a significant impact on the ways households responded to shocks. Specifically, it reduced the reliance on external help from relatives or friends and the need to obtain credit, both of which suggest improved household resilience. Additionally, the intervention significantly decreased the likelihood of selling agricultural assets, helping households maintain their productive base. However, the increase in livestock sales suggests that while households were protected from depleting long-term assets, they still engaged in short-term strategies to cope with immediate needs.

Table 5: Response to experienced shocks

	Impact		Control mean	Observations
Relied on own savings	0.04 (0.10)		0.33	904
Received unconditional help from relatives/friends	-0.26 (0.12)	**	0.18	904
Received unconditional help from government	-0.10 (0.47)		0.00	904
Received unconditional help from NGO/religious institution	-0.21 (0.30)		0.01	904
Changed eating patterns	0.17 (0.11)		0.28	904
Employed household members took on more employment	-0.11 (0.12)		0.09	904

	Impact		Control mean	Observations
Adult household members who were previously not working had to find work	0.06 (0.17)		0.07	904
Household members migrated	-0.12 (0.41)		0.00	904
Obtained credit	-0.38 (0.17)	**	0.07	904
Sold agricultural assets	-0.50 (0.23)	**	0.02	904
Sold durable assets	0.00		0.00	427
Sold livestock	0.27 (0.09)	***	0.09	904
Engaged in spiritual efforts prayer, sacrifices, diviner consultations	-0.14 (0.19)		0.02	904
Did not do anything	0.12 (0.10)		0.22	904

Source: Authors' calculations based on survey data.
Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% level respectively.
Impacts represent the effects from OLS or probit regression, depending on the nature (continuous or binary) of the indicator. Standard errors are presented in parentheses and clustered at the village level. The control mean represents the mean indicator value of untreated household.

VI. Discussion

48. The BYG component of the RRB project aimed to strengthen smallholder farmers' resilience to climate-related shocks by improving food security, household income, and overall adaptive capacity. In this evaluation, resilience is understood as the ability of households to cope with and recover from shocks while maintaining or improving their well-being. The findings provide a nuanced picture of the intervention's short-term effects on participating households in Belize.

49. The intervention generated clear and statistically significant gains in household income. On average, total household income rose by BZD 1,371.59, against a control mean of BZD 5,461. Much of this growth came from crop income (cilantro, tomatoes, sweet pepper, jalapeño, bok choi, cucumber, and green beans) and livestock income (chickens), pointing to a direct translation of project inputs into higher earnings. While this shows tangible short-term economic benefits, it will be important to look more closely at how these income gains are being used (whether for consumption, saving, or reinvestment) and how this shapes longer-term resilience. Such insights would help determine the extent to which the project can drive adaptive capacity beyond immediate financial improvements, especially in the context of smallholder vulnerability to climate shocks.

50. The effects on food security and dietary diversity were more mixed. The intervention increased consumption of protein-rich foods such as meat and poultry, consistent with the provision of chickens and support for vegetable production. However, the Standardized Dietary Diversity Index, which measures the variety of foods consumed over the past week, showed no statistically significant change. This likely reflects the project's targeted crop and livestock focus, with indirect influence on broader diet composition. The absence of a significant shift in the overall index may be due to limited access to other food groups, existing consumption patterns, or the short exposure period. Nonetheless, the shifts in individual food groups point to some dietary changes, even if the overall variety of foods consumed remained stable.

51. One of the most notable findings concerns the intervention's effect on resilience to shocks. Around 70 percent of households experienced at least one shock during the study period, most often flooding (30.3 percent), livestock deaths (29.1 percent), or crop damage (26.9 percent). Beneficiaries reported less severe impacts on income, assets, and food production than the control group, as reflected in a higher Standardized Shock Impact Index. This suggests that BYG support helped households absorb climate-related disruptions more effectively.

52. In particular, the intervention reduced asset losses after shocks, an important factor in maintaining economic stability over time. Protecting agricultural assets is especially critical for sustaining livelihoods. However, the data also show an increase in livestock sales among beneficiaries. This is consistent with livestock serving both as a productive asset and a readily liquid resource. While selling livestock can be a deliberate strategy to address urgent needs without eroding long-term productive capacity, it also indicates that households still need to mobilise assets to respond to shocks.

53. The intervention also influenced coping strategies among households that had recently faced food shortages. Beneficiaries were more likely to limit portion sizes or reduce the number of meals, behaviours that can help stretch resources but also signal ongoing vulnerability. These strategies, captured in the Standardized Coping Strategy Index, apply only to households already experiencing food insecurity and may be affected by seasonal conditions and interview timing. In contrast, the reduction in reliance on help from relatives or friends, and in taking on credit, points to increased self-reliance and reduced dependence on external financial support.

54. These short-term effects are promising, but resilience-building is a long-term process. Many benefits of climate-resilient agricultural practices, such as sustained yield gains, stable incomes, and durable improvements in shock absorption, take multiple growing seasons to fully materialise. Behavioural changes, including the consistent adoption of resilient farming practices and improved dietary habits, also require time to become embedded in household routines. The relatively short time between input

delivery and the endline survey, especially for late recipients, means that some benefits may not yet be visible in the data. Ongoing monitoring will be important to assess whether the observed gains in income, food consumption, and shock management translate into sustained improvements in adaptive capacity. Such follow-up will also help refine the intervention so that its benefits extend beyond short-term recovery to lasting resilience.

VII. Challenges and shortcomings

55. The project experienced procurement delays affecting the timely provision of necessary resources (seeds, livestock, tools). This impacted the sequencing of support provided to households, causing difficulties for participants who received materials (e.g., livestock) before supportive structures such as cooperatives or necessary facilities were in place, leading to preventable losses.

56. From data collection perspective, despite scheduled milestones, inclement weather and unexpected delays in data collection (e.g., some enumerators were available only on weekends) extended the timeline. Additionally, high attrition rates (15 per cent) reduced the completeness of data collected, with remote areas being particularly affected due to limited accessibility:

- The 15 per cent attrition rate (21 per cent in some districts) exceeded initial estimates, leading to reduced sample sizes in certain regions. Efforts to re-contact participants via phone or conduct surveys on weekends helped reduce attrition but were not fully successful. Further, there were instances where households moved or were unreachable, which impacted the control group's consistency. Yet, the balance tests show that there are no systematic differences between the treatment and control group, either on the regional level or in terms of (baseline) household characteristics. Where systematic differences between treatment and control were found at the endline, the differences were controlled for in the impact estimations.
- Translating surveys for communities with Mopan and Kekchi speakers occasionally led to comprehension challenges, which may have influenced the accuracy of responses.
- The climate and agricultural calendar in Belize could influence agricultural outcomes. For instance, weather conditions may have impacted the success of garden harvests, particularly in districts with poor soil quality. This variability might affect generalizability and should be addressed in recommendations.

57. Due to the phase-in design, the evaluation period was relatively short – 6 to 16 months after the intervention. For some of the beneficiaries, this period might have been too soon for full implementation and for realizing the interventions' benefit, which may limit the overall impact of the project and prevent a thorough assessment of its sustainability.

VIII. Conclusion

58. The *Backyard Gardens* component of the *Resilient Rural Belize* project has made a notable and meaningful contribution to enhancing the resilience, income, and adaptive capacity of smallholder farmers in Belize. By introducing climate-resilient agricultural practices and providing tailored support through inputs, technical assistance, and training, the intervention aimed to address the economic, social, and environmental challenges faced by vulnerable rural households in a context increasingly affected by climate shocks. The results of the evaluation show that the BYG intervention achieved measurable short-term impacts, particularly in household income and resilience. Average total household income increased by BZD 1,371 for participants, primarily driven by increases in income from crop production and livestock activities. This outcome demonstrates that the provision of inputs such as seeds, tools, and small livestock, coupled with technical support, effectively translates into tangible economic gains. However, the absence of significant changes in wage income and household expenditure suggests that while income improved, broader economic stability and spending behaviour require further support to achieve sustained transformation.

59. In terms of resilience, the intervention had a particularly significant impact on households' capacity to withstand and recover from shocks. The Standardized Shock Impact Index increased significantly, reflecting a reduced severity of adverse effects on income, food production, and asset endowment among beneficiary households. The intervention also helped mitigate asset losses, which are crucial for long-term economic stability. Importantly, the BYG initiative reduced beneficiaries' reliance on external support and promoted greater self-reliance. While some households resorted to selling livestock to cope with immediate challenges, they were notably less likely to sell critical agricultural assets, preserving their productive capacity for the future. The intervention's effect on food security and dietary diversity was more nuanced. While households reported increased consumption of protein-rich foods, such as meat and poultry, the overall Dietary Diversity Index did not show significant improvement. This highlights the need for complementary measures, such as nutrition education and broader access to diverse food groups, to ensure that increases in food availability translate into balanced and sustainable dietary improvements.

60. Despite these promising results, the evaluation time frame presents an important limitation. With most beneficiaries having received support for only one year or less before endline data collection, the evaluation primarily captures short-term impacts. Climate-resilient agricultural practices, behavioural change, and sustained resilience-building often take longer to materialize fully. For many participants, the benefits of training, input provision, and improved practices are likely to grow over time, particularly across multiple growing cycles. As such, the observed impacts may underestimate the intervention's full potential and long-term effects.

61. The findings underscore the importance of continued monitoring and support to solidify and extend the intervention's gains. Recommendations for future action include sustained monitoring, introducing additional components such as nutrition education, and expanding efforts to improve infrastructure, cooperative support, and climate-smart agricultural practices to enable farmers to adapt to evolving challenges more effectively. The BYG intervention has demonstrated clear potential as a scalable strategy for enhancing the livelihoods and resilience of smallholder farmers in Belize. The significant gains in household income and resilience serve as a strong foundation for further development. By addressing remaining challenges and sustaining long-term efforts, the BYG initiative can contribute to building adaptive, self-reliant, and food-secure communities capable of thriving amid ongoing climate-related challenges.

Appendix 1. Training and support packages and selection criteria

Selection criteria

- Priority beneficiaries will be female-headed households and in order, the extreme poor, poor and then vulnerable households.
- In the Be-Resilient context, backyard gardens will be defined as plots close to the beneficiaries' homes with an average size between 1/8 and ¼ acre.
- The establishment or improvement of backyards will be on an individual or household basis; with each beneficiary responsible for his/her backyard.
- This window requires only the presentation of a simple format, adequate for the educational levels of the target population, to describe the objectives, activities, participants, costs and benefits of the initiative. Backyards are often managed as a smallholder farm with the priority on selling the produce and only secondary to increase consumption at home.
- Backyard gardens, in particular when principles of climate-resilient agriculture are applied, have the potential to improve food security and thereby to strengthen the resilience of the beneficiaries.
- Backyard gardens need to be accompanied by the Climate Smart Agriculture Extension Officer in coordination with the agricultural extension services of the Ministry of Agriculture.

Trainings provided to beneficiaries

BYG beneficiaries received one (1) or a combination of the following:

1. Poultry
2. Vegetable seedlings
3. Pigs

All BYG beneficiaries benefit from a combination of training sessions to assist in leading to a healthier diet, reduce certain household expenditures and improve nutrition, thereby creating sustainability of the BYG intervention among beneficiaries. Targeted training was in the following areas:

Poultry and vegetable beneficiaries

1. Site selection for chicken coop, vegetable gardens
2. Introduction to BYG
3. Elaboration of bio inputs
4. Care and vaccination of chicks

Poultry beneficiaries

1. Site selection for chicken coop
2. Poultry health / care and vaccination of chicks
3. Poultry rearing/ management

Vegetable beneficiaries

1. Site selection for vegetable gardens
2. Vegetable production

3. Elaboration of bio-products

Pig beneficiaries

1. Location of pen
2. Pig feeding and nutrition management

List of communities

District	Community	District	Community
Belize	Bomba	Toledo	Bella Vista
	Boston		Eldridge
	Corozalito		Forest Home
	Lucky Strike		Jacintoville/ Westmoreland
	Maskall		Midway
	Rock Stone Pond		San Antonio
	Santana		San Felipe
	St. Anns		San Isidro
Cayo	7miles/El Progresso		San Miguel
	Armenia		San Pedro Colombia
	Cristo Rey		Santa Ana
	Los Tambos		Santa Cruz
	San Antonio		Santa Elena
	Selena		Silver Creek
	Valley of Peace		Sunday Wood
Corozal	Buena Vista		Trio
	Chan Chen	Orange Walk	Nuevo San Juan (OW)
	Concepcion		San Felipe (OW)
	Cristo Rey (Corozal)		San Roman (OW)
	Louisville		Santa Martha
	Patchakan	Stann Creek	Georgetown
	Ranchito		Maya Mopan
	San Joaquin		Red Bank
	San Narciso		San Roman
	San Pedro (Corozal)		
	San Roman (Corozal)		
	San Victor		

	Santa Clara
	Xaibe
	Yo Chen

Endline summary statistics

Table 6: Household characteristics at endline

	Treatment			
	No	**Yes**	**Total**	**Test**
N	660 (49.0%)	687 (51.0%)	1,347 (100.0%)	
District dummy for belize	0.089 (0.286)	0.092 (0.289)	0.091 (0.287)	0.883
District dummy for cayo	0.186 (0.390)	0.195 (0.397)	0.191 (0.393)	0.685
District dummy for corozal	0.138 (0.345)	0.144 (0.351)	0.141 (0.348)	0.743
District dummy for orange_walk	0.108 (0.310)	0.103 (0.305)	0.105 (0.307)	0.801
District dummy for stann_creek	0.273 (0.446)	0.266 (0.442)	0.269 (0.444)	0.793
District dummy for toledo	0.205 (0.404)	0.199 (0.400)	0.202 (0.402)	0.815
HH head married dummy	0.820 (0.385)	0.811 (0.391)	0.815 (0.388)	0.695
What is the age of the head of household?	45.330 (13.528)	44.480 (13.856)	44.897 (13.698)	0.255
What is the sex of the head of household?	0.223 (0.416)	0.230 (0.421)	0.226 (0.419)	0.751
No formal education	0.274 (0.446)	0.243 (0.429)	0.258 (0.438)	0.192
Completed primary	0.574 (0.495)	0.594 (0.491)	0.584 (0.493)	0.465
Completed secondary	0.147 (0.354)	0.154 (0.361)	0.151 (0.358)	0.707
How many children aged 0–4 in household?	0.456 (0.637)	0.453 (0.648)	0.454 (0.643)	0.923
How many children aged 5–17 in household?	1.636 (1.329)	1.492 (1.279)	1.563 (1.305)	0.042

	Treatment			
	No	Yes	Total	Test
How many household members currently attending school?	1.591 (1.314)	1.447 (1.290)	1.517 (1.303)	0.043
How many elderly aged 60+ in household?	0.279 (0.576)	0.274 (0.575)	0.276 (0.575)	0.870
How many women and girls in household?	2.429 (1.291)	2.301 (1.245)	2.364 (1.268)	0.065
How many men and boys in household?	2.403 (1.390)	2.227 (1.374)	2.313 (1.384)	0.020
How many members belong to your household?	4.832 (2.015)	4.528 (1.981)	4.677 (2.003)	0.005
What is the size of the land in acres which your household has access to?	4.133 (7.810)	4.677 (8.288)	4.411 (8.059)	0.216
What is the size of the land in acres on which your household grows crops?	1.685 (3.294)	2.224 (4.035)	1.960 (3.699)	0.008
Organic fertilizer	0.997 (0.054)	1.000 (0.000)	0.999 (0.036)	0.270
Share of respondents experienced at least one shock	0.652 (0.477)	0.699 (0.459)	0.676 (0.468)	0.065
Number of shocks experienced	1.311 (1.349)	1.461 (1.414)	1.388 (1.384)	0.046
Share of respondents experienced climate shocks	0.383 (0.487)	0.345 (0.476)	0.364 (0.481)	0.144
Share of respondents experienced other shocks	0.547 (0.498)	0.611 (0.488)	0.580 (0.494)	0.017

Table 7: Income summary statistics

	Treatment			
	No	Yes	Total	Test
Total household income	5,466.076 (6,872.307)	6,794.828 (7,613.606)	6,145.238 (7,288.335)	<0.001
Total crop income	292.504 (1,214.131)	470.154 (1,581.326)	383.306 (1,416.051)	0.021
Total livestock income	103.991 (392.068)	126.750 (430.493)	115.624 (412.160)	0.311
Total agricultural wage income	982.822 (2,900.108)	1,193.103 (3,167.577)	1,090.303 (3,040.456)	0.204

	Treatment			
	No	Yes	Total	Test
Total household expenditure	1,209.479 (640.196)	1,170.772 (640.388)	1,189.695 (640.349)	0.267
N	659 (48.9%)	689 (51.1%)	1,348 (100.0%)	

Table 8: Shock responses

	Treatment			
	No	Yes	Total	Test
Standardised Dietary Diversity Index	0.007 (0.517)	-0.007 (0.575)	-0.001 (0.547)	0.642
Relied on own savings	0.326 (0.469)	0.337 (0.473)	0.332 (0.471)	0.738
Received unconditional help from relatives/friends	0.178 (0.383)	0.117 (0.322)	0.146 (0.353)	0.009
Received unconditional help from government	0.002 (0.048)	0.002 (0.046)	0.002 (0.047)	0.935
Received unconditional help from NGO/religious institution	0.014 (0.118)	0.008 (0.091)	0.011 (0.105)	0.413
Changed eating patterns	0.277 (0.448)	0.328 (0.470)	0.304 (0.460)	0.093
Employed household members took on more employment	0.089 (0.285)	0.077 (0.268)	0.083 (0.276)	0.522
Adult household previously not working had to find work	0.070 (0.256)	0.073 (0.261)	0.072 (0.258)	0.871
Household members migrated	0.002 (0.048)	0.002 (0.046)	0.002 (0.047)	0.935
Obtained credit	0.073 (0.260)	0.036 (0.185)	0.053 (0.224)	0.013
Sold agricultural assets	0.016 (0.127)	0.004 (0.065)	0.010 (0.099)	0.064
Sold durable assets	0.002 (0.048)	0.000 (0.000)	0.001 (0.033)	0.290
Sold livestock	0.092 (0.289)	0.138 (0.345)	0.116 (0.321)	0.029
Engaged in spiritual efforts, prayer, sacrifices, diviner consultations	0.023 (0.152)	0.017 (0.128)	0.020 (0.140)	0.470

	Treatment			
	No	**Yes**	**Total**	**Test**
Did not do anything	0.225 (0.418)	0.262 (0.440)	0.244 (0.430)	0.207
N	659 (48.9%)	689 (51.1%)	1,348 (100.0%)	

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