LORTA

Impact evaluation report for FP069

Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity in Bangladesh

March 2024

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

IMPACT EVALUATION REPORT FOR FP069 — ENHANCING ADAPTIVE CAPACITIES OF COASTAL COMMUNITIES, ESPECIALLY WOMEN, TO COPE WITH CLIMATE CHANGE INDUCED SALINITY IN BANGLADESH

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175, Art center-daero
Yeonsu-gu, Incheon 22004
Republic of Korea
Tel. (+82) 032-458-6450
Email: ieu@gcfund.org
https://ieu.greenclimate.fund

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Credits
Head of the GCF Independent Evaluation Unit: Mr. Andreas Reumann
Task manager: Dr. Anastasia Aladysheva, Impact Evaluation Specialist a.i., Independent Evaluation Unit
Editing: Beverley Mitchell
Layout and design: Giang Pham
Cover photos: (front) © Farhana Bilkis/Center for Natural Resource Studies (CNRS) Bangladesh; (back) © Lopez Rello/UNDP

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In 2018, the Independent Evaluation Unit initiated the Learning-Oriented Real-Time Impact Assessment (LORTA) Programme, within which it collaborates with the impact evaluation specialists and academics, project teams funded by the Green Climate Fund (GCF) and local evaluation teams. The LORTA programme incorporates state-of-the-art approaches for impact evaluations to measure results and raise awareness about the effectiveness and efficiency of GCF projects. The impact evaluation of project "FP069: Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity in Bangladesh" was designed to align with the LORTA approach for measuring causal impacts.

The LORTA programme has a twofold aim: (i) to embed real-time impact evaluations into funded projects for generating evidence about what works and what not in climate adaptation and mitigation; and (ii) to build capacity within projects to design high-quality data sets for overall impact measurement. The purpose of the impact evaluations is to measure the change in key results areas of the GCF that can be attributed to project activities. The LORTA programme is informing on the impacts of GCF projects and helps GCF projects track implementation fidelity.

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List of authors

The authors of this midline impact evaluation report are (in alphabetical order of the surnames):

Full name	Affiliation
Al Harun, Abdullah	United Nations Development Programme, Bangladesh
Aladysheva, Anastasia	Independent Evaluation Unit, Green Climate Fund
Avdeenko, Alexandra	The World Bank and the University of Heidelberg
Das, Sudeb Kumar	United Nations Development Programme, Bangladesh
De Vries, Martina Gintarė	World Intellectual Property Organization, Geneva
Gaertner, Jakob	University of Heidelberg
Gillaizeau, Marc	University of Mannheim and Center for Evaluation and Development
Hossain, Mohammad Iftekhar	United Nations Development Programme, Bangladesh

ABBREVIATIONS

BDT	Bangladeshi taka
DW	Drinking water
EWS	Early warning systems
FCS	Food Consumption Score
FP	Funding proposal
GCF	Green Climate Fund
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
HH	Household
HHI	Hirschman–Herfindahl Index
ICC	Intra-cluster correlation
IGA	Income-generating activity
ITT	Intention-to-treat
LH	Livelihood
LORTA	Learning-Oriented Real-Time Impact Assessment
M&E	Monitoring and evaluation
MDES	Minimum detectable effect size
MIS	Monitoring and information system
MoWCA	Ministry of Women and Children Affairs
ND-GAIN	Notre Dame Global Adaptation Initiative
NGO	Non-governmental organization
OLS	Ordinary least squares
p.c.	Per capita
pp	Percentage point
RCT	Randomized control trial
RWHS	Rainwater harvesting systems
SD	Standard deviation
SE	Standard error
ToC	theory of change
UNDP	United Nations Development Programme
UPs	*Union parishad*
USD	United States dollar
WLGs	Women's livelihood groups

EXECUTIVE SUMMARY

South-western Bangladesh, a region characterized by its vulnerable population and high levels of poverty, has witnessed a significant increase in efforts to provide livelihood support to marginalized communities, particularly women. The vulnerability of the local populations has been increasing due to climate change, which causes numerous high-intensity floodings, monsoons and typhoons. Rising sea levels and increased flooding increase soil salinity. These events significantly impact agricultural activities, limit freshwater access and have a direct implication on people's well-being. Recognizing the immense potential of empowering women to achieve sustainable development in this region, various programmes and initiatives have been started in recent years to enhance women's socioeconomic status.

The project "FP069: Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity" has been approved and financed by the Green Climate Fund and the Government of Bangladesh since 2018 (a total of USD 33 million). The accredited entity for this project is the United Nations Development Programme, and the executing entity for this project is the Ministry of Women and Children Affairs in Bangladesh. With its activities, the project highlights the significance of empowering women, providing them with opportunities for skills development through training sessions, access to agricultural inputs and financial support to promote agricultural adaptation, and market access.

The aim of this impact evaluation is to independently examine the impact of the livelihood support component of this project on women's lives in two southern districts, Khulna and Satkhira. The impact evaluation focuses on carefully identifying the project's causal effects on various dimensions of households' well-being and resilience to climate change shocks as impact indicators, including women's empowerment, to assess the effectiveness of this project. The evaluation also descriptively investigates possible mechanisms such as providing clean drinking water solutions at the household level. This mechanism, for example, may free up women's time that was previously used to fetch water and enable women to use it for income-generating activities.

The evaluation strategy employs a stratified randomized control trial with a phase-in component, meaning that the selected control group of households receives intervention at a later stage, leaving "no one behind". As a source of evidence, the impact evaluation analyses baseline and endline household data on 3,120 beneficiaries, especially women. The analysis focuses on statistical methods.

The findings of the impact evaluation show that the average total household income increased by over 14,000 Bangladeshi taka (approximately USD 165) between September 2021 and November 2022, which corresponds to approximately a one-month average salary in Bangladesh. The food security measured by the Food Consumption Score increased by 8 per cent, which could be a direct outcome of the increased welfare. Programme-assigned beneficiaries exhibit a 4 percentage point increase in their perception of household preparedness against future extreme weather events. However, the data suggest that the baseline measures of household preparedness were already relatively high (i.e. before project implementation, around 90 per cent of households responded that they were prepared against future extreme weather events).

With respect to women's empowerment, the results indicate a higher share of women engaged in at least one income-generating activity, which increased by 8.3 percentage points between baseline and endline data collection. However, the project did not lead to increases in women's decision-making over household spending of income, suggesting that established gender roles may be continuing to act as a barrier for women's empowerment.

The findings of this impact evaluation contribute to the existing body of knowledge by providing evidence-based insights into the impact of livelihood support programmes on women in south-western Bangladesh and similar contexts. This study adds new understanding by examining the specific challenges faced by women in these communities and the effectiveness of tailored interventions in addressing those challenges, thereby expanding our knowledge base on women's economic empowerment and climate change adaptation projects.

One of the limitations of this impact evaluation is that it explores the short-term impacts of the programme and is not able to provide insights on, for example, health, children's education or other long-term outcomes. Another limitation is that this impact evaluation did not explore the community-level outcomes, such as social cohesion, that might be influenced by the project and that may be a large contributor to community resilience. In addition, the evaluation did not utilize qualitative methods in order to complement the findings from the quantitative approach.

Despite the existing limitations, the findings provide insights for stakeholders, policymakers and practitioners for designing and implementing more effective livelihood support programmes that can empower women in south-western Bangladesh and similar contexts and contribute to women benefiting from sustainable development. By enhancing livelihood support for women, these initiatives can pave the way for gender equality, women's empowerment and more resilient communities that are prepared for climate change.

I. INTRODUCTION

1. Despite producing only 0.4 per cent of global greenhouse gas emissions, Bangladesh ranks seventh on the list of countries most affected by extreme climate events from 2000 to 2019, according to Germanwatch 2021 Global Climate Risk Index.[1] Most of the country sits less than 10 metres above sea level, with especially low-lying areas in the southern part of the country, situated on the Bay of Bengal.[2] The population in these areas is highly vulnerable to climate-related hazards such as flooding, cyclones, storm surges, salinity and sea level rises. Since 2000, Bangladesh has suffered economic losses worth more than USD 3.7 billion and witnessed over 180 extreme weather events due to climate change (Rojas, 2021). The country is being significantly impacted by this, given that almost 1 in 4 Bangladeshis – 24.3 per cent of the population – live in poverty. Poverty rates and population density levels are particularly high in the coastal regions.
2. **In 2018, the Green Climate Fund (GCF) and the Government of Bangladesh financed the adaptation project "FP069: Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity".**[3] The project's accredited entity is the United Nations Development Programme (UNDP). The project aims to increase the capacity of coastal communities, especially women, to adapt to changes exacerbated by current and upcoming changes in the climate. The project has three key outputs or components: (i) providing livelihood support, especially for women, to enhance the adaptive capacities of coastal agricultural communities, (ii) providing drinking water at the household and community levels, and (iii) strengthening institutional capacities, knowledge and learning for the climate-risk-informed management of livelihoods and drinking water security (Green Climate Fund, 2018).
3. **The programme has been designed to meet urgent needs.** For example, in the Khulna district of Bangladesh, citizens experience reductions in their crop production due to increased salinity, which affects their resilience to climate shocks. A recent study by Khan, Hasan and Kabir (2022) has established that increased crop growth as well as education and membership in community-based social groups are important factors to increasing climate resilience. In the long run, livelihood support may stabilize citizens' income over time and have a positive impact on household food security, which is positively correlated with long-term resilience to climate shocks (Ansah, Gardebroek and Ihle, 2019). Moreover, the specific focus on women is a key targeting mechanism, given that the development literature has long emphasized the importance of supporting women for various sets of indicators. When women have access to income-generating opportunities, they and their families are more likely to escape poverty and improve their standard of living. Increasing women's labour-force participation can boost gross domestic product growth and promote economic development, as well as drive innovation and productivity (Pimkina and de la Flor, 2020). Supporting women's livelihoods can also help women to challenge and overcome gender-based inequalities in various spheres of life (Hans and others, 2021; Khalil and Jacobs, 2021; Khalil and others, 2020). It can boost their self-esteem and self-worth (Saptaningtyas and others, 2023), thereby improving their overall health. This can also have a positive implication for the education and health of women and their children.

[1] Retrieved from the open source Germanwatch, available at https://www.germanwatch.org/en/19777.
[2] See Figure A - 1.
[3] Within the GCF's portfolio, Bangladesh ranks 24th for number of projects, with seven projects as of January 2023. Nonetheless, Bangladesh is one of the most funded countries, ranking sixth based on approved financial support.

4. Moreover, especially in the rural regions of low-income countries, women and children predominantly bear the responsibility for fetching water (Sorenson, Morssink and Campos, 2011; Geere and Cortobius, 2017). Agesa and Agesa (2019) found that females in sub-Saharan Africa drop out of or spend less time at school due to the responsibility of fetching water. Similarly, spending considerable time on this activity has been proven to cause adverse effects on women's and children's education and health, as well as to have a negative implication on household income and intra-household dynamics in Bangladesh (Tenhunen, Uddin and Roy, 2023; Islam, 2020). Young women in Bangladesh frequently sacrifice their education to fetch water, especially if the water source is located far from home. The difficulty of fetching water is further exacerbated by frequent floods or droughts, which require additional travel to acquire non-saline water (Sharmin and Islam, 2013). The need to travel to non-saline water sources has been described as a cause of women spending a lot of time acquiring fresh water, frequently enduring extended queues and being susceptible to conflict over water (Mehzabin and Mondal, 2021). Improved access to water may therefore enhance the social and economic status of women, by providing them with more time to allocate towards productive activities. Finally, capacity-building and awareness-raising activities on climate change adaptation and sustainable agricultural practices, which are an essential part of the FP069 project, may help women to make informed decisions and actively contribute to adaptation efforts, at both the household and community levels.
5. **This impact evaluation analyses the impact of component 1 of the programme – that is, its livelihood support – on a wide range of outcomes.** The study area is in two coastal south-western districts, Khulna and Satkhira. The underlying impact evaluation design employs a stratified randomized control trial (RCT), in which 25 *union parishad* (UPs), which are the smallest rural administrative and local government unit in Bangladesh, were offered an intervention in 2022, and another 14 UPs were treated in November 2022 (after the endline survey was completed). The baseline data from 3,120 female-headed households were collected in September 2021, and the endline data were collected in October 2022. The attrition rate was 9.7 per cent, which corresponds to around 300 households. The rate was within the expectations of the research team, and the missing households were replaced for the endline sample. The potential influence of component 2 is descriptively assessed as a potential mechanism for changes in income levels. The impact evaluation has been ongoing since 2019 – that is, since before programme implementation started – as part of the Learning-Oriented Real-Time Impact Assessment (LORTA) programme for long-term engagement in impact evaluation and implementation tracking.
6. **The results of this impact evaluation suggest that the UNDP livelihood support programme provides women with much-needed income support and has a positive impact on household food security.** The impact evaluation finds that the project led to an increase in household income of over 14,000 Bangladeshi taka (BDT) (approximately USD 165)[4] between September 2021 and November 2022, which corresponds to approximately a one-month average income in Bangladesh. Household food security, as measured by the Food Consumption Score, increased by 8 per cent, which could be a direct implication of the increased income. Programme-assigned beneficiaries exhibit a 4 percentage point (pp) increase in their perception of household preparedness against future extreme weather events. However, the data suggest that the baseline measures of household preparedness were already relatively high, with around 90 per cent of households responding that they were prepared against future extreme weather events before the project implementation. With respect to women's empowerment, the results indicate a higher share of women engaged in at least one income-generating activity (IGA), which increased by 8.3 pp. However, the project did not lead

[4]We use the average exchange rate of 2021 (BDT 1 = USD 0.0118) to convert currencies from BDT to USD. See https://www.exchangerates.org.uk/BDT-USD-spot-exchange-rates-history-2021.html.

to increases in women's decision-making over household spending of income, suggesting that it could be difficult to change deeply ingrained attitudes such as gender roles in the short term.

7. **With this new evidence, the report shall contribute to a scarce but rapidly growing body of scientific literature on the evidence of climate-related adaptation interventions.** So far, the evidence has been claimed to remain insufficient to draw any rigorous conclusions or policy recommendations (Doswald and others, 2020). Empirical evidence from impact evaluations is most concentrated in sub-Saharan Africa and within the agricultural sector, with a lack of evidence for Asia and climate adaptation measures in the water sectors. Lack of evidence on climate adaptation projects is also evident for projects specifically targeting female-headed households, which are argued to be the most vulnerable to climate-related shocks. Béné and Haque (2022), for instance, do not establish a conclusive link between sustainable fishing livelihood support, primarily provided to women, and improvements in nutrition and food security in central coastal regions of Bangladesh. Conversely, Mannan and Ahmed (2012) study the impact of several livelihood support activities and find a positive effect on the food security of households headed by single or separated women, or women with disabled partners. Relatedly, a study in rural Bangladesh by Kang and others (2022) established that livelihood programmes providing poultry and agricultural trainings (gardening skills) to households had resulted in increased food security, greater crop diversification and higher income. Moreover, a recent LORTA impact evaluation study in Malawi found that the capacity-building training on adaptation for farmers, who are predominantly women, led to poverty reduction and changes in the agricultural production of maize (Independent Evaluation Unit, 2022). Further evidence on multi-sectoral approaches, such as access to clean water, livelihood support and capacity-building efforts, is needed to identify the most effective interventions that contribute to more resilient and sustainable outcomes in Bangladesh and similar contexts.

II. CONTEXT

8. Bangladesh is one of the world's highest-ranking nations in terms of population and lies to a great extent in one of the world's largest active deltas. This extremely complex and dynamic delta system, which continues to change over time, brought favourable living conditions through fertile soil and access to water (Akter and others, 2016). Yet while the delta forms a home to many communities, the delta system remains a vulnerable environment that is highly susceptible to river channel migration, river erosion, sedimentation, tides and waves. While the vulnerability of the environment can be affected by human interventions, changes in the climate will have a considerable influence on the future evolution of the delta system.
9. Natural disasters are a large contributor to Bangladesh's vulnerability. Between 1961 and 2013, 61 cyclones hit the nation, of which 28 per cent majorly affected the country's south-western region (Quadir and Iqbal, 2008) with storm surges ranging from 1.5 to 10 metres (Brammer, 2014). The south-western region is categorized as a tide-dominated area of the delta system (Islam, 2016). This implies that the area is vulnerable to changes in sea level. Bangladesh has experienced far more than the average observed trends of sea level rise (<4 mm/year), with an observed sea level rise of 6–21 mm/year along the coast of Bangladesh (Climate Change Cell, 2016). Given the ongoing global warming, Bangladesh is likely to face a further sea level rise of up to 88 cm by 2100 (Bangladesh, Ministry of Environment and Forests, 2005).
10. The south-western region has also been facing significant challenges that arise due to its low elevation, saline water intrusion, soil erosion (caused by, among others, extensive land usage and sand picking) and the increasing occurrence of natural disasters. Sea level rises, changes in river discharge, land usage and the already low elevation are possible causes that lead to increased seawater intrusion into freshwater areas. The increased salinity has two major consequences for the vulnerable population: (i) it directly damages crops and freshwater fish stocks (which are not resilient to these levels of salinity), which then decreases the productivity of agriculture and aquaculture activities; and (ii) it increases salinity in the groundwater, damages water supply infrastructure, increases the distances to drinking water sources and causes a deterioration of overall drinking water quality. These impacts lead to a loss of income, a loss of agricultural livelihoods, and growing drinking water insecurity that is associated with adverse health impacts.
11. Women and girls are more affected by these impacts than men. Studies show that women are more likely than men to have adverse health impacts (e.g. hypertension) due to salinity (Nahian and others, 2018). Moreover, high salinity in drinking water can be associated with pre-eclampsia and gestational hypertension during pregnancy (Khan and others, 2011; 2014). From an economic point of view, traditional gender roles, which are especially present in rural areas of Bangladesh, lead to lower access to formal employment for women (Ahmed and Sen, 2018). Aside from care work, women mainly engage in agriculture and livestock-related activities (UN Women and Bangladesh Centre for Advanced Studies, 2014). Therefore, owing to a lack of alternative income sources, women's options to generate income are disproportionately affected by the loss of productive agricultural land. In addition, men are forced to migrate to engage in more profitable non-farming activities when agricultural productivity is reduced or becomes less lucrative, which increases the vulnerability of their families.
12. Since the late 1990s, Bangladesh has continued to make significant efforts to invest in measures to reduce the impacts of disasters and to increase climate resilience (World Bank, 2010). Nonetheless, despite these efforts, the country's vulnerability remains high. Bangladesh is ranked 156 out of 185

countries on the ND-GAIN Country Index,[5] indicating its high vulnerability to and low resilience against climate shocks. This vulnerability has severe implications as environmental disasters continue to hinder advancements in economic growth and poverty reduction.

13. Policies aimed at bolstering climate-risk resilience have gained prominence on the national agenda since the early 2000s. These policies include the *Bangladesh Climate Change Strategy and Action Plan* (2008), the *National Adaptation Programme of Action* (Bangladesh, Ministry of Environment and Forests, 2005), the *Mujib Climate Prosperity Plan* (Climate Vulnerable Forum and V20 Presidency of Bangladesh, 2021) and the *Bangladesh Delta Plan 2100* (Bangladesh, General Economics Division, 2022). Through the *Bangladesh Climate Change Strategy and Action Plan*, the Government of Bangladesh has set a clear vision to ensure the well-being of its entire population. This vision is centred around the aspiration to create a climate-resilient strategy that ensures energy, water, food and livelihood security. It reflects the Government's commitment to adapt to and mitigate climate change impacts by prioritizing climate resilience within, among others, these critical areas of water and livelihood security (Bangladesh, Ministry of Environment and Forests, 2008), which are still considered one of the primary goals within the *National Adaptation Plan of Bangladesh 2023–2050* (Bangladesh, Ministry of Environment, Forest and Climate Change, 2022). In line with this national strategy and prioritized critical areas, the GCF-funded (co-financed with the Government of Bangladesh) project "FP069: Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity" is set out to enhance resilience through early warning systems, access to drinking water and the training of women in climate-resilient livelihoods.

[5] Country ranking of Bangladesh as of 19 October 2023. Retrieved from the ND-GAIN Country Index, available at https://gain.nd.edu/.

III. PROJECT DESCRIPTION

14. In February 2018, at its nineteenth meeting, the GCF Board approved the project "FP069: Enhancing adaptive capacities of coastal communities, especially women, to cope with climate change induced salinity" in Bangladesh. The project is financed by a grant of USD 25 million from the GCF, as well as by a grant of USD 8 million from the Government of Bangladesh. The project is currently expected to be completed in October 2024. Its implementation, by UNDP, began in 2019, and it was onboarded into the IEU's LORTA programme for an impact evaluation that same year.
15. The project falls under two GCF results areas: (i) health, food, and water security and (ii) livelihoods of people and communities. The key goal of the project is to strengthen the adaptive capacities of coastal communities against the impacts of climate change, through the adoption of climate-resilient livelihoods and an increase in the availability of drinking water. The main target population is women, who are vulnerable to climate change induced salinity, in two districts in the coastal area of south-western Bangladesh – namely, Khulna and Satkhira. These two districts have been prioritized, given that their salinity exposures are the highest among the priority districts. The goal is to expand and scale the solutions to the remaining four districts (Bagerhat, Pirojpur, Barguna and Patuakhali).
16. FP069 is a GCF flagship project, with a specific focus on gender. The impact evaluation results will be used by UNDP in the potential scaling up of the project in other areas of Bangladesh and will also inform the GCF about the impact of adaptation support on women.
17. The project consists of three interlinked components:
    - Component 1 – Climate-resilient livelihoods
        - Enterprise- and community-based implementation of climate-resilient livelihoods for women
        - Strengthened climate-resilient value chains and market links for adaptive, resilient livelihoods
        - Community-based monitoring and last-mile dissemination of early warnings for climate-risk-informed, adaptive management of resilient livelihoods
    - Component 2 – Drinking water solutions
        - Participatory, site-specific mapping, beneficiary selection and mobilization of community-based management structures for climate-resilient drinking water solutions
        - Implementation of climate-resilient drinking water solutions (at household, community and institutional scales)
        - Community-based and climate-risk-informed operation, maintenance and management of resilient drinking water solutions
    - Component 3 – Strengthening of institutional capacity, knowledge and learning
        - Strengthening of the technical and coordination capacities of the implementing partners (the Ministry of Women and Children Affairs and the Department of Public Health Engineering)
        - Establishment of knowledge management, learning, and monitoring and evaluation mechanisms

18. Component 3 of the project is an overarching component that is aimed at strengthening the executing entity and the partner institutions. This component may indirectly impact all the households in the project areas and beyond and is not subject to this impact evaluation.
19. One of the goals of the project is to promote synergistic co-benefits between the different activities. As a result, all project areas will be covered by the last-mile dissemination of early warning information, and eligible beneficiaries will benefit from the drinking water solutions and adaptive livelihood activities. The three types of activities are described in more detail below, and section V details the evaluation methodology, including the selection of specific project components for causal evaluation.

A. ADAPTIVE LIVELIHOOD ACTIVITIES

20. The project aimed to form or reactivate around 1,017 women's livelihood groups (WLGs) of approximately 25 women per group. The project presents eight livelihood options, and each WLG selects three of these options, for which they are trained.[6] After the training is complete, each WLG is asked to select two out of the three trained livelihoods, for which they receive input support (USD 160 per household). The eight livelihood options were selected to be appropriate for women's engagement and empowerment, as well as to be suitable for local market conditions.
21. WLGs can receive in-kind input support for up to three production cycles on the two livelihood options selected after the training. Additionally, the Government of Bangladesh provides extra support (through co-finance) in the form of direct cash transfers to the beneficiaries. These cash grants remain blocked on the beneficiaries' accounts until the WLGs are adequately structured to allow pooling the money together, which will serve for making larger investments and for accessing finance.[7]

B. EARLY WARNING SYSTEMS

22. To equip the target group with the capacity to undertake adaptive planning and management of the new climate-resilient livelihoods, it was necessary to raise awareness and understanding of climate-risk reduction strategies. First, the project aimed to work with local authorities to tailor messages from existing early warning systems (EWS) to the needs of the local population. For this, complex meteorological data was to be summarized and provided, along with clear information on the potential consequences of upcoming weather events, complemented by clear instructions on how people should react and protect themselves. Second, women early warning volunteers, the majority of whom are part of the WLGs, were to be trained in the selected wards in coordination with the Cyclone Preparedness Programme and disaster management committees at the UP level. These activities were aimed at improving EWS dissemination and gender-responsive messaging.

C. DRINKING WATER SOLUTIONS

23. The drinking water solutions consist mainly of constructing rainwater harvesting systems (RWHS) to ensure water supply during the dry season, which runs from November until February in

[6] The eight livelihood options are crab fattening, crab nursery, crab and fish feed processing, homestead gardening, aqua-geoponics, hydroponics, sesame cultivation, and plant nursery.
[7] The cash transfers were made in June 2022 and June 2023, amounting to a total of around BDT 5,000 (USD 45) per beneficiary. At the time of writing the report, beneficiaries had not yet been able to access this extra cash.

Bangladesh.[8] RWHS use was exclusively directed at drinking water, not at water resources for agriculture, cooking or personal hygiene. This activity was the largest part of the project in terms of budget and included the development of new and innovative technology for RWHS.[9]

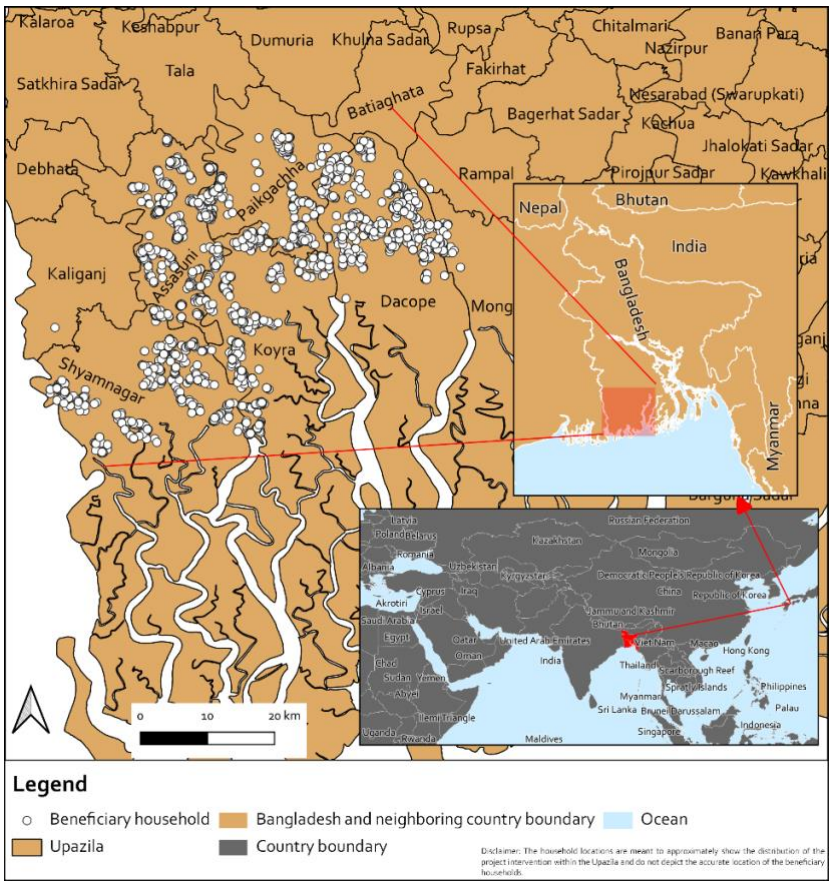
24. The project planned to build 13,308 RWHS at the household level,[10] 228 RWHS at the community level (i.e. at mosques, temples or other community buildings); 19 RWHS at the institutional level (i.e. at schools or other government institutions); and 42 pond embankments and filtration systems.[11] At least 20 per cent of target households in each project ward should receive household-based RWHS.[12]
25. Water user groups and water management committees were to be formed to ensure sustainable planning and maintenance of the water solutions. The water user groups consist of women of targeted households who received training at workshops and are responsible for smaller maintenance tasks on a daily or monthly basis. Bigger maintenance operations are taken care of by a technician from the water management committee at the ward level.[13]
26. According to the project documentation, an estimated 719,229 people would benefit directly and indirectly from the project intervention. This equals around 16.25 per cent of the total population in the two districts. In total, 245,516 direct beneficiaries (50.2 per cent female) are targeted by the project. All beneficiaries are to be reached by the EWS component. The livelihood component targeted 25,425 beneficiaries, all female, and the drinking water component targeted 136,110 beneficiaries, of which 50.2 per cent were female.
27. The direct beneficiaries were chosen based on their need for support, as identified from a census conducted in early 2021. In particular, the following criteria were used for the selection of direct beneficiaries:
    - Women aged 18-59 years old, responsible for water collection and/or able to adopt a climate-resilient livelihood strategy
    - Adolescent girls that are married early and are solely responsible for household income generation
    - Households with incomes less than USD 1.9 per person per day, having few or no assets, and beneficiaries who are compelled to accept employment at low wage rates
    - Women-headed households (including those widowed, divorced or separated/abandoned) or households where a man cannot work; or with a large number of dependent family members (chronically ill, physically, mentally or visually impaired or disabled)
    - Households with less than 50 decimals (2,023 m^2) in total land
    - Indigenous ("*Adivasi*") households; Hindu minority households will be represented in proportion to their overall population in the wards
    - Women beneficiaries that have not been a recipient of a governmental or NGO scheme of a similar nature and/or quantity of support within the last two years
28. Nearby communities in the targeted wards are expected to benefit indirectly from the project through knowledge-sharing and learning mechanisms.

[8] The climate in Bangladesh is characterized by a short spring – from March to May – and a long season of rains, which runs from June to October, followed by the dry season.
[9] Access to drinking water was also provided by other partners in the target area, but the other types of water interventions differ from the one that was offered in this project.
[10] The capacity of a household water tank is 2,000 L.
[11] Community-level and institutional RWHS cover between 25 and 200 households, depending on their type and size. The 288 community-level RWHS aim to cover 20,205 households in total.
[12] See section VI.D for details on implementation progress for drinking water solutions.
[13] A small fee is charged annually for basic maintenance and operation, varying per level. Beneficiaries of household-level RWHS are additionally encouraged to set aside an amount for further repairs.

29. Within the two implementation districts, Khulna and Satkhira, 39 UPs were selected (18 in Satkhira and 21 in Khulna) across five *upazilas* (Assasuni, and Shyamnagar in Satkhira district; Dacope, Koyra and Paikgachha in Khulna district). Within the selected UPs, 101 out of 351 wards were selected (see Figure III–1). The 39 UPs were selected based on their exposure to salinity, including projected salinization, and prevalence of extreme poverty. The 101 wards were selected based on the following criteria:

- Current and projected salinity level (based on maps of soil salinity)
- Poverty index (based on income poverty, percentage of day labourers and satellite imagery analysis of housing structures)
- High exposure to salinity intrusion due to low elevation levels[14]

Figure III–1. Project and beneficiary location map



Source: Authors.

30. Before the project implementation, village and community-specific mapping and participatory planning were conducted. Owing to the difficult COVID-19 situation in Bangladesh, as well as several natural disasters (e.g. Cyclone Amphan in May 2020), this stage of the project took longer than expected and was finalized in November 2020. Table A - 1 provides an overview of completed activities.

31. Also, before the implementation of project activities (December 2020 – January 2021), a full household census was carried out in the project wards to gather the information required to compute the household vulnerability scores that determine eligibility for treatment. The census data

[14] The selection of project areas was carried out by the project team at UNDP Bangladesh.

collection included 66,171 households and was used to randomly select a baseline sample for the impact evaluation.

32. WLG formation and ward-level livelihood profiling were completed and built the basis for the implementation of the livelihood component. In November 2021, training of trainers on adaptive livelihoods started in the project UPs. Participants in the training of trainers were responsible for delivering training to the WLGs. After training was completed, each WLG received input support for two out of the three livelihood options that they were trained on. Input support lasted for three production cycles, totalling between 12 and 18 months depending on the type of livelihood.[15,16]
33. In parallel, the implementation of drinking water-related activities was initiated in November 2021. Seven community- and institution-based RWHS were installed in six UPs, functioning as a pilot, before the installations in the outstanding UPs.[17] Water quality testing took place thereafter.

[15] Some livelihoods have longer production cycles than others.
[16] At the central level, a training of trainers workshop for Ministry of Women and Children Affairs staff on the gender–climate nexus was held in December 2021.
[17] Consultation meetings on fee-based modelling of community-, institution- or pond-based RWHS installations were completed in December 2021.

IV. THEORY OF CHANGE

34. Figure IV–1 presents the theory of change (ToC) associated with the two types of project activities that are subject to the impact evaluation – namely, the livelihood component and the drinking water component. The LORTA and UNDP teams developed the ToC together during the design stage of the evaluation. The ToC displays the needed inputs and activities, which are expected to translate into intended outputs and outcomes. In the longer term, several aspects of the beneficiaries' (and their respective households') lives are intended to be impacted by their project participation.
35. In the livelihood component, financial and human resources are required for the creation or reactivation of WLGs across the project area, with women from beneficiary households as members. The eight adaptive livelihoods that the project focuses on are promoted to the WLGs, and each WLG chooses three of the livelihoods to receive training on. After the training, the WLGs choose two livelihood options, for which they receive input for one to three production cycles.[18] The intended outcome is that the project beneficiaries, who have received training and inputs for livelihoods, sustainably adopt those livelihoods. In the final stage, this is to translate into an impact on the women's income, as well as their decision-making power within the household. Through an increase in women's income, the household income is expected to increase. One intended impact of the project is income stability, and – through income increases – the household food security situation is expected to improve.
36. In the drinking water component, financial and human resources – together with construction materials – were needed as inputs for the implementation of the second project component, which entailed the construction of household and community-based RWHS. The intended outcome of this component is that beneficiary households will have year-round access to clean drinking water closer to their houses. Because women are mainly responsible for fetching water in Bangladesh,[19] this component is expected to translate into their spending less time doing so. This, in return, is expected to translate into women having more time to participate in WLGs and adopting adaptive livelihoods.
37. The livelihood and drinking water components are highly interlinked. The assumption that women will adopt the adaptive livelihoods (assumption 2) depends on women having enough time to engage in IGAs, which is directly influenced by the drinking water component as, in addition to its direct purpose, it should reduce women's time spent fetching water. In addition, for women to have sustainable means of earnings, they needed to be able to protect their new livelihoods against extreme weather events, which would only be possible if the EWS subcomponent had been carried out successfully and effectively.
38. Each link of the causal chain established by the ToC relies on several crucial assumptions, indicated in Figure IV–1 by numbers or letters (numbers 1–8, letter M), which are used as references when explaining all underlying assumptions:
    1) Livelihood component: inputs to activities
        a) All needed inputs are available.
    2) Livelihood component: activities to outputs
        a) All identified beneficiaries belong to a WLG.

[18] The number of production cycles covered by input support depends on a group's ability to take over and sustain the investments and management required for the chosen livelihood options, which is referred to by the project as "graduation". When a group graduates, input support from the project will stop, even if they received said support for only one or two rounds. As of December 2023, no group has yet graduated.
[19] In the majority of households included in the baseline sample, solely women are responsible for fetching water.

b) Women in WLGs are motivated, have time to participate in the trainings and are allowed by their partners or families to participate.

c) WLGs are able to consensually choose three livelihoods for training.

3) Livelihood component: outputs to outcomes

a) WLGs are able to consensually choose two livelihoods for input support.

b) Training and inputs are sufficient to equip women with the necessary knowledge and material to start engaging in adaptive livelihoods.

c) Women have the necessary prerequisites to permanently engage in livelihoods (e.g. time they can dedicate to activity, land ownership and decision-making power).

4) Livelihood component: outcomes to impacts

a) Adaptive livelihoods are adequate and adapted to context (e.g. resistant to saline soil and weather conditions).

b) Market links are established so that production from adaptive livelihoods can meet the demand.

c) There is sufficient demand to sell the production from adaptive livelihoods.

d) Adaptive livelihoods generate profits.

5) Census data

a) Census data are collected from all households in target areas.

b) Census data allow eligible households to be correctly identified as per the criteria defined by the project.

6) Drinking water component: inputs to activities

a) All needed inputs are available.

b) There is adequate knowledge to construct the RWHS.

7) Drinking water component: activities to outputs

a) There is enough material to construct the RWHS.

8) Drinking water component: outputs to outcomes

a) RWHS are operational.

b) There is enough rain during the rainy season to fill the tanks.

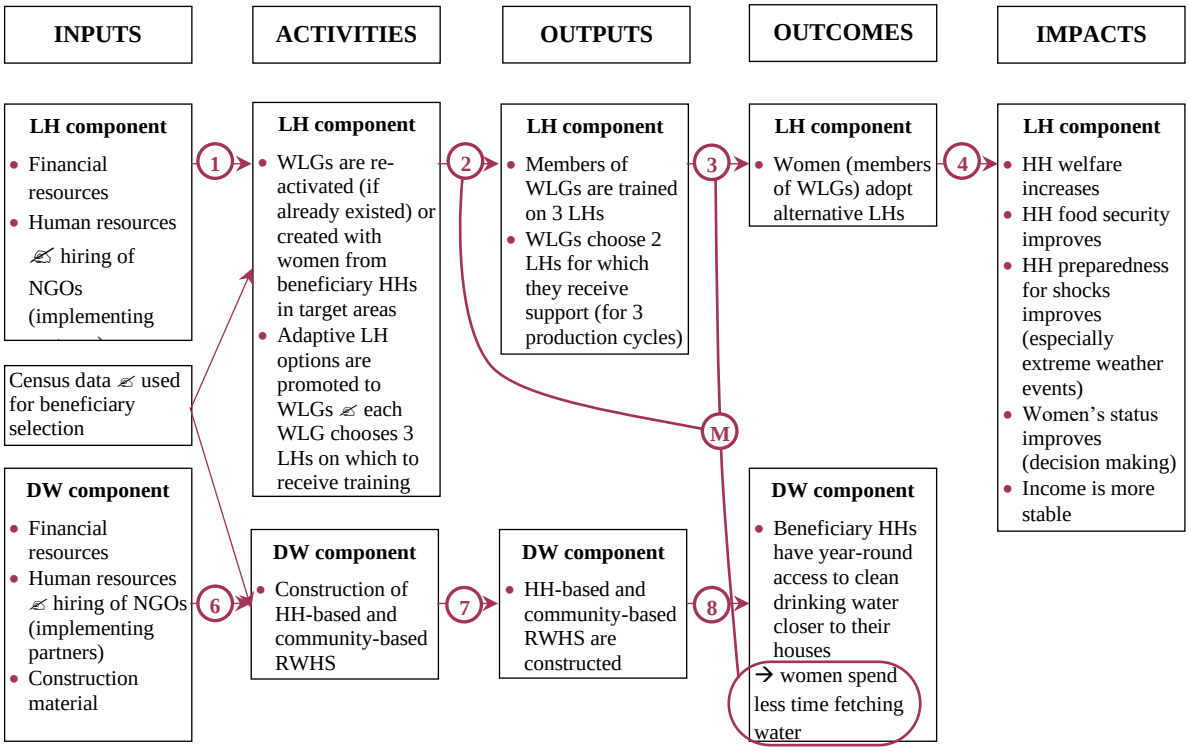
c) RWHS are solid and can resist extreme weather events.

9) Mechanism (M)

a) Women reallocate time from fetching water towards training on adaptive livelihoods.

b) Women reallocate time from fetching water towards IGAs – in particular, adaptive livelihoods promoted by the project.

Figure IV–1. Theory of change of the livelihood and water components of FP069



Source: Authors.
Notes: NGO = non-governmental organization, DW = drinking water, HH = household, LH = livelihood

V. EVALUATION METHODOLOGY

A. EVALUATION OBJECTIVE, EVALUATION QUESTIONS AND INDICATORS

39. The ToC and its underlying assumptions, as well as project implementation updates, guided the formulation of the evaluation questions. The questions are tested in this endline analysis to inform whether the implementation of the intervention had an impact on key outcomes of interest. The overarching question, which constitutes the starting point of the evaluation design, is as follows.

40. ***Overarching evaluation question:*** *Did the programme increase the capacity of beneficiaries to adapt to climate change, especially women?*

41. Notwithstanding its intrinsic value, such a question is too broad to be answered directly by an impact evaluation. Therefore, during the scoping mission the evaluation team identified – in collaboration with the project team – a set of more precise evaluation questions in line with the project ToC, relating to the individual impacts of each project component.

42. In practice, each evaluation question would require a specific variation in treatment – either in the intensity, timing or coverage of its various components – to allow for the identification of the corresponding causal impacts (i.e. for the attribution of measured impacts to the respective treatment modality). Given the contextual circumstances and constraints inherent in project design and implementation, as well as budgetary and timing considerations, it was not feasible to accommodate all the required treatment variations within a single impact evaluation, and hence not possible to answer all evaluation questions within a single causal study. For the drinking water component, introducing experimental variation was not in line with the component's underlying social ethics, given the urgency of the situation.[20] For the EWS component, activities involved a complex collaboration between multiple actors (from the project or not) at multiple levels (ward and UP), and there was no clear potential for experimental variation.[21]

43. Therefore, and in line with discussions with the project team, the counterfactual impact study focuses on the livelihood component and the following evaluation questions. Section B elaborates on the design of the impact evaluation in more detail.

44. ***Evaluation question:*** *Did the adaptive livelihoods promoted by the programme provide sustainable means of earnings, especially for women?*

45. This evaluation question could be answered by measuring the impact on the following **indicators**:

- Intermediate indicator[22]
  - Adoption rate of adaptive livelihoods
- Final indicators
  - Household income and expenditure
  - Revenues from IGAs – in particular, adaptive livelihoods

[20] The project team stated that the issue of drinking water was too pressing and too crucial for the life of people in the project areas to allow randomly not implementing or delaying the implementation of drinking water solutions.
[21] In addition, the scope of the component was somewhat larger than the project areas, as some activities take place at the UP level, hence covering both project and non-project wards. This aspect made the process of identifying a suitable control group more difficult.
[22] "Intermediate indicator" refers to direct and short-term or immediately visible outcomes; "final indicator" refers to long-term outcomes.

- Household income stability[23]
- Asset ownership, used to estimate an index that proxies household wealth
- Household Food Consumption Score (FCS)
- Household Food Insecurity Access Scale (HFIAS) developed by Swindale and Bilinsky (2006)
- Household resilience to shocks (exposure to natural disasters, consequences of said disasters on household livelihood, how well the household has recovered, time preferences, attitudes towards risk)

46. Additionally, we formulated the following question related to the key mechanisms targeted by the project to achieve impacts:

47. ***Mechanism:*** *Do the drinking water solutions provided by the programme allow beneficiaries to engage in IGAs, especially women?*

48. **Indicator:** Time allocation (trade-off between time spent fetching water and time allocated to IGAs).

49. Table V–1 maps key indicators to the various elements of the impact evaluation ToC.

Table V–1. Key indicator descriptions and measurement

ToC	Item	Indicator	Data source
LH component Activities	WLGs are reactivated (if they already existed) or created with women from beneficiary households in target areas	No. of WLGs in target areas	MIS
		No. of women who report membership	Survey
	Adaptive LH options are promoted to WLGs. Each WLG chooses three LHs on which to receive training	No. of WLGs that received information and chose three LHs for training	MIS
Assumption 2 and Mechanism M	Women in WLGs are motivated, have time to participate in the trainings and are allowed by their partners or families to participate	No. of beneficiaries who attended and received training	MIS Survey
		Time allocation of women	Survey
	Women reallocate time from fetching water towards training	Women's decision-making power in the household	Survey
LH component Outputs	Members of WLGs are trained on three LHs	No. of training sessions delivered	MIS
		Topics covered in training	MIS Survey
	WLGs choose two LHs for which they receive input support (for three production cycles)	No. of WLGs that receive input support	MIS Survey
		No. of beneficiaries that receive input support	MIS Survey
Assumption 3	Training and inputs are sufficient to equip women with the necessary knowledge and material to start engaging in adaptive LHs	Extent of input support	MIS Survey

[23] For details on measurement, see section V.C.

ToC	Item	Indicator	Data source
LH component Outcomes	Women (members of WLGs) adopt adaptive LHs	No. of beneficiaries who practise adaptive LHs	MIS Survey
		Time allocation of women	Survey
Assumption 4	Adaptive LHs are adequate and adapted to context (e.g. resistant to saline soil and weather conditions)	Type of LH adopted by beneficiaries	MIS Survey
	Adaptive LHs generate profits	Household profits from adaptive LHs	MIS Survey
LH component Impacts	Women's income increases	Women's income generated	Survey
	Women's status improves (decision-making)	Women's decision-making power in the household	Survey
		Women's participation in social life	Survey
		Women's participation in adaptive LHs (self or women only versus joint production with partner or husband)	Survey
	Household income increases	Household income	Survey
		Household expenditures (proxy)	Survey
	Income is more stable	Household income shares	Survey
	Household food security improves	Household FCS	Survey
		HFIAS score	Survey
		Household food expenditure	Survey
	Household preparedness for shocks improves (especially extreme weather events)	Household assets	Survey
		Self-reported preparedness	Survey
DW component Outcomes	Beneficiary households have year-round access to clean DW closer to their houses	No. of beneficiaries who have access to household-based DW solutions	MIS Survey
		No. of beneficiaries who have access to community-based DW solutions	MIS
		No. of households whose members suffered from waterborne disease	Survey
	Women spend less time fetching water	Time allocated by women to fetching water	Survey
Mechanism M	Women reallocate time from fetching water towards IGAs – in particular, adaptive LHs promoted by the project	Time allocation of women	Survey

Source: Authors.
Notes: MIS = monitoring and information system

B. IMPACT EVALUATION DESIGN

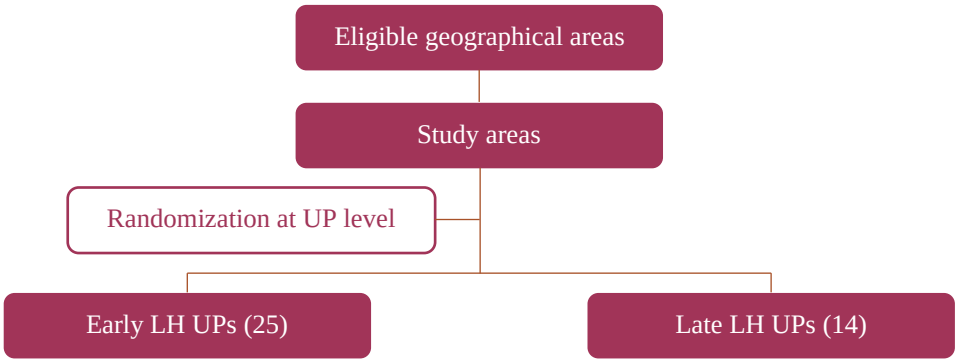
1. ELIGIBLE POOL AND COMPARISON GROUP

50. The project decided to select, as a priority, the most vulnerable UPs and, within these, the most vulnerable wards. As a result, non-project UPs and non-project wards are intrinsically different from project areas. Furthermore, within the selected wards, the project identified specific households as eligible for treatment based on demographic and socioeconomic criteria. An ideal comparison group consists of similarly eligible households within treatment areas to ensure that the comparison households exhibit similar background characteristics to treatment households. Similarly, selecting a comparison group from within treatment areas would alleviate concerns regarding programme placement bias.

51. The impact evaluation follows a clustered phase-in RCT, where project UPs are the clusters.[24] In this set-up, all eligible households eventually received the livelihood programme activities as planned.[25] The livelihood intervention was rolled out in two phases: project activities were implemented only in the first group during Phase 1 and extended to the second group during Phase 2. The project identified 39 project-eligible UPs; the first group of 25 UPs received the livelihood interventions during Phase 1, and the second group of 14 UPs received them during Phase 2.[26]

52. The roll-out of livelihood activities took place from February 2022 in Phase 1 UPs and from November 2022 in Phase 2 UPs. With the staggered implementation, beneficiaries in the UPs of Group 2 (the "Late LH" group in Figure IV–1) constitute the control group for the impact evaluation, as summarized in Table V–2. The clustered phase-in design is experimental in nature, as the groups were assigned to each phase **randomly** (see Figure IV–1).

Figure V–1. Clustered phase-in design



Source: Authors.

[24] UNDP conveyed that assignment to groups should be made at the UP level, rather than at the ward, village or individual household level. From an operational standpoint, the choice of UPs as the treatment assignment units was expected to increase the capacity of the implementing partners to comply with the experimental design.
[25] Not all wards are part of the project within a given project UP. The project identified project wards within the selected project UPs, and eligible households were identified within said project wards through the project census data.
[26] In principle, a phase-in design could count more phases. The choice of having two groups and keeping a smaller share of target UPs in the control group was made in consultation with UNDP, taking into account UNDP's programmatic and operational commitments.

Table V–2. Phase-in of livelihood interventions with two groups

PHASE	TREATMENT GROUP	COMPARISON GROUP
1	**Group 1** No. of UPs: 25 No. of wards: 65[a] Planned No. of LH beneficiaries: 16,416[b]	**Group 2** No. of UPs: 14 No. of wards: 36[a] Planned No. of LH beneficiaries: 9,009[b]
2	**Group 1 + Group 2** No. of UPs: 39 No. of wards: 101 Planned No. of LH beneficiaries: 25,425	

Source: Authors, based on preliminary beneficiary lists shared by UNDP in June 2021.
Note: [a] Estimated before randomization based on the average number of wards per UP.
[b] Estimated before randomization based on the average number of LH beneficiaries per UP.

53. Importantly, as the roll-out of livelihood activities started in Phase 1 UPs in February 2022 and endline data were collected in October 2022, the causal study designed here is able to capture only **short-term** programme impacts (i.e. after eight months of exposure to the programme) and cannot assess their sustainability over time.

2. RANDOMIZATION PROCEDURE

54. Table V–3 presents the allocation of Phase 1 and Phase 2 UPs for each NGO (implementing partner) and *upazila*. The allocation by NGO was made arbitrarily[27] by the evaluation team to ensure that each NGO had more UPs to cover during Phase 1 than during Phase 2. In addition, the randomization procedure implemented by the evaluation team accounted for *upazila*-level stratification.

55. The rationale for stratifying at this level is twofold: (i) it ensures that each *upazila* includes both Phase 1 and Phase 2 UPs, and (ii) given that the catchment areas of the implementing partners are defined by *upazila*, stratification at the *upazila* level mechanically implies stratification at the NGO level, which in turn mitigates concerns relating to implementer bias (if organizations implement the programme in a different way).[28]

[27] A random choice was required because the overall allocation ratio (25/14) did not yield round numbers when applied to each NGO, given the low number of UPs.
[28] Implementer bias can arise when several organizations implement a single programme. The source of the bias is that said organizations may implement programme activities in different ways (e.g. according to the culture or experience of the organization implementing that activity). Such a situation begs the question of whether the programme is actually comparable across the various implementing agencies and, hence, whether the estimated impacts may be affected by heterogeneity that actually reflects differences between implementers.

Table V–3. Randomization – allocation of UPs by upazila

NGO	*Upazila*	Total No. of UPs	No. of UPs Phase 1 implementation	No. of UPs Phase 2 implementation
BRAC	Assasuni	10	6	4
DSK	Dacope	9	6	3
CNRS	Koyra	7	5	2
DSK	Paikgachha	5	3	2
CNRS	Shyamnagar	8	5	3
Total		**39**	**25**	**14**

Source: Authors, based on project data.
Note: BRAC = Bangladesh Rural Advancement Committee, CNRS = Center for Natural Resource Studies, DSK = Dushtha Shasthya Kendra

56. The allocation was enforced by implementing the following procedure for each *upazila* separately, using the project census data:
    1) Sort observations based on the UP identification number (variable called "union" in the project census data).
    2) For each UP within that *upazila*, generate a random number in the range [0,1] drawn from a uniform distribution.
    3) Sort the UPs based on the value of the random numbers (in ascending order).
    4) Repeat steps 2 and 3 one hundred times.
    5) From the resulting random sorting of UPs, assign the first *n* UPs to Phase 1 implementation. For example, in Assasuni, the first six UPs were assigned to Phase 1 and, in Koyra, the first five UPs were assigned to Phase 1.
57. The impact evaluation team used the project census data to check the balance across Phase 1 and Phase 2 UPs (see Table A - 5).

C. Data

1. Data collection

58. Three data sources are used in the analysis of the livelihood programme: a census, which also served as a needs assessment for the programme, and two waves of data collection.

a. Census

59. The census data, covering 66,171 households residing in the project area, were collected in January 2021. The rich data set includes information on the demographic background of household members, the socioeconomic status of households, access to drinking water, the household's food security situation, the household's exposure to natural disasters and the respondent's perception of climate change. The questions were answered by a female household member knowledgeable on the listed topics.
60. While most sections were kept short, the census gathered detailed information on sociodemographic characteristics, which was not collected again during the baseline survey for two main reasons: (i) this information is not likely to change during such a short period (between January and September 2021), and (ii) to shorten the duration of the extensive interviews conducted at baseline, which

focused on collecting data on key indicators before the implementation of the project activities. The census was used as a sampling frame to randomly select a baseline sample for in-depth structured interviews, which included 3,120 households eligible for the project.

b. Baseline data collection

61. The baseline data were collected in September 2021 from a randomly selected sample of households residing in five *upazilas*, divided into 39 UPs targeted by the project. Out of these, households in 25 UPs participated in the project in Phase 1, serving as the treatment group. Households in the remaining 14 UPs gained access to the intervention in Phase 2, hence forming the comparison group for the impact evaluation. A total of 3,120 households (80 households in each UP) were interviewed following a random selection from a census of all households that were identified as eligible for the programme. In total, 2,000 beneficiaries benefited from the intervention in phase 1, and there were 1,120 beneficiaries in phase 2.
62. The baseline data collection was organized and executed by UNDP, deploying UNDP staff and project ward facilitators. During the baseline survey, enumerators administered the interviews in two parts. First, they asked questions on household composition, asset ownership and access to finance, access to drinking water, income, food consumption and expenditure.[29]
63. During the second part of the interview, the respondent changed to a female household member (unless she was also being interviewed during the first half). The female respondents were then asked questions on the household's food security, the IGAs she was involved in and the respective income decision-making, knowledge about climate change and adaptation to it, preparedness for natural disasters, social capital, market access and attitudes towards risk.

c. Endline data collection

64. The endline survey took place in October and November 2022 (concluding on 2 November) and was carried out by a data-collection firm (Nielsen Company Bangladesh Limited). The sampling strategy for the endline survey aimed to trace and re-interview all households surveyed during the baseline phase. In case of failure, the interview was conducted with a replacement household for the respective group (i.e. treatment or comparison). The list of replacement households was prepared briefly before the launch of the endline survey. The sampling followed exactly the same sampling strategy as for the baseline sample.
65. The endline sample comprised a total of 3,120 households, with 303 replacement households. The attrition analysis describes if and how the attrition (i.e. participants who dropped out or were lost to follow-up between the baseline and endline surveys) affects our results.
66. The endline survey captured information on almost all modules covered at baseline. The module on miscellaneous time-fixed household information was dropped because this information is only needed as baseline characteristics. Two new modules were added, one about savings and loans and one about EWS. Finally, certain questions were removed, added or modified to improve the questionnaire and its flow.

2. Data quality assurance

67. The LORTA team provided quality assurance throughout the entire evaluation process for the project's impact evaluation. Before data collection could take place, the LORTA team provided several rounds of feedback on the base and endline questionnaire.

[29] The target respondent for this part of the interview was the household member most knowledgeable about the household livelihood.

68. Upon finalization and during data collection, the respective data-collection team undertook numerous procedures to ensure the collection of high-quality data through training of the field team, pilot tests, the appointment of supervisors, enumerator assessments, back checks (in-person re-visits and telephone checks) and enumerator debriefs. In the case of the baseline data collection, the UNDP team ensured that about 30 per cent of the interviews were manually checked by the supervisors daily. Thereafter quality data checks were immediately performed by trained UNDP staff, to follow up with enumerators on inconsistencies and for them to return to the respondent whenever necessary. For the endline data collection, 16 per cent of the interviews were accompanied by a supervisor that was assigned to five enumerators. In terms of the back checks, 12 per cent of the interviewed households were re-visited and 10 per cent were reached over the phone.
69. The data collection experienced certain challenges during the baseline and endline phases. Because of the COVID-19 pandemic, extra health and safety measures had to be taken into consideration. Cyclone Sitrang caused heavy rains in late October 2022, which disrupted the endline data collection: three days after the start of the endline data collection, the team had to pause for several days before they could continue the interviews.
70. After the completion of data collection, the project team shared all data with the LORTA team. The LORTA team then developed and carried out ex-post data quality checks to thoroughly assess the quality of the data and to identify inconsistencies and queries in a way that complemented the data quality checks that had been performed during data collection. In particular, the team examined the consistency of key outcome variables (or variables used to create such outcomes) to detect, for example, outliers, missing data and duplicates. The LORTA team then shared its findings with UNDP to clarify where the identified inconsistencies might stem from and, when found necessary, requested corrections. All feedback from the project team was incorporated into the data to ensure that the data were in optimal shape for analysis. After the quality checks were completed, the remaining duplicates and errors were addressed and taken note of.

3. Data preparation and outcome variables

71. The following steps were undertaken for the construction of specific outcome variables:
    - All income and expenditure outcome variables refer to household per capita amounts. To ensure comparability across survey waves, all monetary amounts are expressed in September/October 2021 BDT (i.e. the time of the baseline data collection). Endline values are deflated using the exchange rates prevailing in September/October 2021 and October/November 2022 (i.e the time of endline data collection).
    - Household food nutrition is measured by the FCS following the World Food Programme methodology (World Food Programme, Vulnerability Analysis and Mapping Branch, 2008). Household food security is assessed with the HFIAS of the United States Agency for International Development's Food and Nutrition Technical Assistance Project (Coates, Swindale and Bilinsky, 2007).
    - Household overall income diversification is estimated by the inverse Hirschman–Herfindahl Index (HHI).[30] Income diversification is constructed based on income shares from the following sources: crop production, livestock, agricultural wage employment, wage employment in non-agricultural activities, non-farm household enterprises (self-employment), transfers and other sources.[31] A higher value of the inverse HHI represents a higher degree of

[30] In studies of income diversification in Bangladesh, Sherf-Ul-Alam and others (2017) and Rehan, Sumelius and Bäckman (2019) use the Simpson index of diversification, which is the reciprocal of HHI and hence qualitatively similar.
[31] In line with the income sources defined by the Rural Income Generating Activities project conducted by the World Bank and the Food and Agriculture Organization of the United Nations. See Carletto and others (2007).

overall income diversification, hence a positive (or negative) impact estimate represents a positive (or negative) programme impact income diversification.

72. Unless explicitly stated otherwise, the reference period for all outcome variables is "in the last 12 months" (relative to the date of the survey).

73. Once all the variables necessary for the analysis were generated, the sample was trimmed (removing outliers in the data) using the following algorithm implemented by Crépon and others (2015):

- For all main continuous outcome variables, compute the ratio of the variable value to the 90th sample percentile.
- Take the maximum ratio for each observation across said outcomes, and rank observations based on this maximum value.
- Drop the 0.5 per cent of observations with the highest ratios.[32]

74. In the present study, the trimming procedure results in a sample of 3,104 endline observations for analysis, instead of the original 3,120. The rationale for trimming outliers is that the regression framework proposed for the analysis (see section D) relies on ordinary least squares (OLS), an estimator that is famously sensitive to extreme observations due to its focus on the conditional mean. However, outliers do not always consist of measurement errors or data mistakes and are precious in providing information on units that experience extreme realizations of the outcome variable. The approach suggested by Crépon and others (2015) aims to strike a balance between the two (i.e. to stabilize OLS estimates while retaining meaningful information).

4. Balance tests

75. Selected variables from the census data were used to carry out preliminary balance tests, after the randomization procedure, across Phase 1 and Phase 2 UPs (reported in Table A - 5). There is no statistically significant imbalance for the selected variables.

5. Attrition

76. During the endline survey, interviewers utilized Global Positioning System data from the baseline interviews to enhance the likelihood of locating the same respondents. If individuals were not available during the first visit, two additional follow-up phone calls were made before categorizing them as "unavailable". These follow-up calls were spread over one week after the initial visit. Interviewers sought assistance from neighbours to locate and identify the intended interviewees.

77. The eventual attrition rate was 9.7 per cent. Out of the 3,120 individuals interviewed during the baseline survey, 303 could not be re-interviewed at the endline. The difference in dropout rates between the treatment and control groups is 4.1 pp, which is statistically significant at the 5 per cent level. Specifically, the attrition rate in the treatment group is 11.2 per cent, whereas it is 7.1 per cent in the control group.

[32] One may decide to drop a larger or smaller proportion of the sample.

Table V–4. Completed interviews by treatment status

Treatment status	Completed interviews		Target (n. obs.)	Attrition rate (%)
	Match w. baseline	Substitution		
Treatment	1,777	223	2,000	11.15
Control	1,040	80	1,120	7.14
Total	**2,817**	**303**	**3,120**	**9.71**

Source: Authors.

78. Table V–5 presents why programme-assigned beneficiaries could not be surveyed at endline, split by assigned treatment status. This information was collected from other household members or neighbours. The main reason for attrition is that the respondent was not available after one visit and two calls (79.87 per cent). The share is higher for treatment-assigned households by 22.6 pp (1 per cent significance level). In 17.82 per cent of the cases, the respondent moved away or migrated (mostly due to economic reasons such as finding a job in Dhaka). The share is lower for households assigned to treatment than households assigned to control (by 17.9 pp, 1 per cent significance level). Only one respondent refused to participate in the endline survey, and six respondents died between the baseline and endline surveys.

Table V–5. Reasons for attrition, split by treatment status

Reason	(1) Share of total attritted	(2) Share of attritted in Treatment	(3) Share of attritted in Control	(4) = (2) – (3) Difference between treatment and control
Respondent not available after three visits	0.798 (N=242)	0.861 (N=192)	0.625 (N=50)	0.226***
Respondent refused to participate in the interview	0.003 (N=1)	0 (N=0)	0.0125 (N=1)	-0.0125*
Respondent died	0.019 (N=6)	0.013 (N=3)	0.038 (N=3)	-0.025
Respondent moved away/migrated	0.178 (N=54)	0.126 (N=28)	0.325 (N=26)	-0.179***
Total number of observations	**303**	**223**	**80**	

Source: Authors.
Note: Number of observations (reported in brackets in each cell) correspond to the share relative to the total number of observations for each column (reported in the last row). Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

79. Those individuals who dropped out predominantly belonged to households headed by females and were less likely to marry. Recontacted households showed a statistically significant higher proportion of female household members belonging to community-based groups. Furthermore, dropped-out households owned less agricultural land (statistically significant). These findings suggest that households with weaker community ties are more likely to drop from the survey.

80. Was non-response influenced by the programme? To explore non-random attrition, two OLS regressions were conducted: (i) regressing the attrition dummy variable on treatment status, relevant baseline characteristics and their interaction; and (ii) regressing the attrition dummy variable on treatment status, relevant baseline outcomes and their interaction. The regression specifications

mirror those used in the main regression analysis. The regression results are presented in Table A - 6 and Table A - 7, which include joint tests for selective attrition.

81. The first regression shows that ownership of land is negatively correlated with attrition status (5 per cent significance level). The interaction between treatment and the size of agricultural land is negatively correlated with attrition status. In the second regression with baseline outcomes, the F-tests, serving as tests of joint significance, indicate that the covariates are jointly correlated with attrition status, suggesting that attrition overall is not random. However, the coefficient on the treatment variable is not statistically significant, suggesting that treatment assignment alone does not predict if a respondent attritted between the baseline and endline survey. The variable of food insecurity (as measured by the HFIAS) exhibits high statistical significance. Higher levels of food insecurity are positively correlated with attrition, indicating that households facing greater challenges in accessing food are more likely to be unavailable for interviews. Additionally, the negative correlation between the interaction of food insecurity and the treatment dummy variable with attrition status is statistically significant. In essence, food security is a key (associative) factor for attrition.

82. Given the evidence of potential attrition bias in the study sample, part of the robustness analysis consists of testing the sensitivity of the main results to attrition.

D. EMPIRICAL STRATEGY

1. IDENTIFICATION OF CAUSAL EFFECTS

83. The phase-in clustered RCT provides a straightforward analytical framework to estimate the short-term impacts of the livelihood component of the project. The analysis focuses on the intention-to-treat (ITT) effect – that is, the impact of being exposed to (or offered) treatment, which in this case is the effect of being offered the livelihood project activities. In short, the ITT captures the impact of being exposed to the project. The ITT is estimated in a linear regression of the form:

$$Yi = \alpha + \beta Ti + \gamma Yi + Supz + ei \quad (1)$$

84. where Y_i is the value of the outcome of interest at the endline for household i, α is a constant, T_i is a dummy variable equal to 1 if household i lives in a Phase 1 UP (and 0 otherwise), Y_{i0} is the baseline value of outcome Y for household i, S_{upz} is a set of dummy variables controlling for stratification at the randomization stage (i.e. *upazila*-level fixed effects), and e_i is the household-level error term clustered at the UP level.[33] In that setting, the coefficient estimate for parameter β identifies the ITT.[34] To deal with missing values in pre-treatment outcome variables (due to attrition), we code said missing values as 0 and augment the regression by an indicator variable equal to 1 if the baseline value is missing.[35]

[33] In that instance, clustering is used to account for the experimental design and the fact that treatment is assigned at the UP level. As MacKinnon, Nielsen and Webb (2019) put it: "When the regressor of interest is a treatment dummy, and the level at which treatment is assigned is known, then it generally makes sense to cluster at that level […] If treatment is assigned by cluster, […] it never makes sense to cluster at a level finer than the one at which treatment is assigned."
[34] While Athey and Imbens (2017) recommend favouring the analysis of experimental data through a simple comparison of the treatment and control groups (of course, accounting for design specificities such as stratification and clustering), McConnell and Vera-Hernández (2015) show that the inclusion of baseline outcome values as a covariate increases the precision of impact estimates, typically dominating a simple post-intervention comparison in terms of statistical power. Therefore, we choose to leverage the availability of baseline data and to augment our regression specification by including the pre-treatment (i.e. baseline) value of the outcome variable as an extra covariate.
[35] See, for example, Angelucci, Karlan and Zinman (2015), "Microcredit Impacts: Evidence from a Randomized Microcredit Program Placement Experiment by Compartamos Banco", for an application of this approach.

2. MULTIPLE HYPOTHESIS TESTING

85. When a large number of comparisons are investigated in one experiment, the probability of falsely rejecting true null hypotheses increases with the number of tests carried out. In other words, the larger the number of tests, the higher the likelihood of finding a significant impact on at least one outcome, even if the project did not have one in reality. This is referred to as a type I error, or "false positive". It is crucial to account for multiple hypothesis testing to mitigate the risk of making erroneous policy recommendations.[36] The issues relating to multiple hypothesis testing may arise when testing the significance of the impact of a single treatment on several outcome variables, when testing the impact of multiple treatments in a multi-arm setting, or during a combination of both.

86. Following guidance from Anderson (2008), we control the false discovery rate – that is, the expected proportion of false positives, given a collection of statistical tests – within outcome "families". We define an outcome family by grouping outcome variables that measure or proxy the same (or similar) socioeconomic phenomenon or behaviour, and hence effectively *test* the same hypothesis. Each group of variables reported in a single table corresponds to an outcome family – see the results tables in section VI.B. Similarly, outcome families are indicated by headers in Figure VI–1.

87. To control the false discovery rate, we follow the two-step procedure developed by Benjamini, Krieger and Yekutieli (2006) – presented in Anderson (2008) – to adjust p-values and compute sharpened q-values to test the significance of ITT estimates obtained from regression specification (1). A nice feature of this approach is that sharpened q-values are interpreted the same way as regular p-values.

3. ROBUSTNESS ANALYSIS

a. Attrition

88. The report discusses the various sources of attrition in the study sample and presents evidence of potentially systematic differences between those households who attritted and those who were interviewed in both waves of data collection. Such non-random attrition is a concern for the study as it could bias impact estimates. Ideally, one would test whether the estimated ITT is significantly different for households who attrit, but the latter do not have endline outcome data. Instead, we test whether the ITT is statistically different for households who were interviewed solely at the endline compared to households who were successfully interviewed in both survey waves. The test simply consists of augmenting regression specification (1) with an interaction term between the treatment assignment variable and an indicator variable equal to 1 if the household was interviewed only at the endline. A significant coefficient estimate on the interaction term could indicate a potential attrition-led bias in ITT estimates.

b. Outliers

89. The trimming procedure used in the present study provides an objective algorithm to strike a balance between reducing the noise in the data and retaining some information on extreme values. Nonetheless, the chosen proportion of the sample to be trimmed (0.5 per cent of observations in our case) may seem arbitrary. Therefore, the sensitivity of ITT estimates to this choice is tested by repeating the analysis after trimming 1 per cent, 2 per cent and 5 per cent of the data.

[36] Indeed, recommending an intervention that did not yield benefits would be very costly.

c. Randomization inference

90. In the main analysis based on regression equation (1), standard errors (SEs) are clustered at the UP level because treatment was randomly assigned at that level. Although clustering at the UP level is conceptually sound and in line with "design-based" inference (Abadie and others, 2020), there is a risk that "conventional" analytical clustered SEs are biased downward due to the moderate number of clusters (39) in our study (see Cameron, Gelbach and Miller, 2008). We use randomization inference as a robust method to provide inference in a complex design, even with few clusters. Randomization inference is based on permutations that allow testing of sharp null hypotheses. For this impact evaluation, the sharp null of interest is that of "no treatment effect for any unit in the sample". This differs from the typical null hypothesis of "no average treatment effect", for which a regression-based approach gives a direct test. (The weaker hypothesis of "no average treatment effect" is implied by the sharp null.) The algorithm to conduct randomization inference is straightforward:
    1) In the original sample, generate a "fake" treatment variable using the same (random) assignment rule as for the actual randomization procedure.
    2) Estimate and store the desired quantity based on the "fake" treatment variable, in our case the ITT, following the regression specification in equation (1).
    3) Repeat steps 1 and 2 a large number of times (here, 1,000 times).
    4) The sharp p-value is given by how often (in percentage) the quantity estimated in step 2 is larger than the quantity estimated with the actual treatment.
91. The advantage of randomization inference is that it does not depend on modelling, but rather considers randomization itself as the source of uncertainty in the estimated statistics. As a result, it mechanically takes into account non-trivial design elements, such as stratification and clustering. For more details on randomization and inference, see Heß (2017) and Young (2019).

4. Additional descriptive analysis

92. As explained in section IV, one of the key mechanisms intended by the project is that providing drinking water solutions should help reduce the time spent by women on fetching water, in turn freeing up some time for women to engage in IGA – in particular, the adaptive livelihoods promoted by the project. As this component was not part of the randomization implemented for the evaluation study, it is not possible to do a proper mediation analysis to understand whether this mechanism can causally explain part of the measured impacts of the adaptive livelihood component. Instead, we investigate the matter descriptively by focusing on summary statistics linking access to drinking water solutions to survey data on time allocation.
93. In addition, we explore descriptively the monitoring data shared by the project team on the extent of input support received by beneficiaries as part of the livelihood component, in an attempt to better contextualize the findings.

E. Ethics

94. The LORTA team is highly committed to following ethical principles and has followed these in all stages of the research and data-collection process. The LORTA team consulted on an ongoing basis with local partners to ensure the ability of the research team to capture the complexity of the context and to develop adapted approaches within the study design as well as the data collection.

95. The LORTA team applied for ethical clearance for the impact evaluation (including the endline survey) at the Institute of Health Economics (University of Dhaka), which was granted in August 2022.
96. The LORTA team engaged early on with the project team to conduct a careful risk–benefit assessment, to ensure that risks to the study participants were minimized and that appropriate risk mitigation mechanisms were in place. Therefore, the proposed impact evaluation design ensured that all study participants were to benefit from the project (i.e. no participant was to take part in the evaluation without participating in the project). The suggested phase-in design foresaw that treatment households participated in Phase 1, while the comparison households benefited from the project during Phase 2.
97. Early engagement ensured respondents' safety and privacy and allowed for anonymity to be maintained during the interviews. This engagement included the request for support letters and authorization from local authorities to ensure that the data collection was conducted in a way that protects the rights, safety and dignity of participants according to regulations prevailing in Bangladesh. Before fieldwork, UNDP and the survey firm committed to training all enumerators in ethics. This was to ensure that the impact evaluation team adhered to the following core principles of research, among others:
    - Obtaining informed verbal consent from the participants
    - Minimizing the risk of harm to participants
    - Protecting participants' anonymity and confidentiality
    - Avoiding using deceptive practices
    - Giving participants the right to withdraw from the evaluation
98. Electronic data-collection survey instruments were developed and deployed in the field on tablets. Consent was recorded for all survey respondents. Respondents were made aware of the nature of the evaluation and how their data would be used. For instance, the material used for training was shared with UNDP by the relevant survey firm before starting fieldwork. Pseudonyms were used, and any identifiers (personal information) were removed from the final data sets.

VI. IMPACT EVALUATION RESULTS

99. This section is divided into two parts, guided by the ToC. First, in part A, we investigate whether the livelihood programme was successful in delivering its activities to the intended beneficiaries in the treatment group. In this section, we also check if the programme activities were successful in translating to the planned programme outputs and outcomes. The descriptive statistics on programme activities, outputs and outcomes include t-tests to compare the treatment and comparison groups.
100. Second, part B reports the average ITT effects for selected outcomes of interest, the key results of the study. The outcomes of interest follow the ToC and are grouped accordingly (household welfare, food security, shock preparedness, women empowerment). The ITT is estimated via OLS regression including randomization strata (i.e. *upazila*) dummy variables and the baseline outcome value as covariates, while SEs are clustered at the UP level and adjusted for multiple hypothesis testing (see section V.D for methodological details). The ITT analysis uses outcome data from the endline survey cleaned from outliers (see section V.C for details on data preparation).
101. Results from the main analysis are complemented by a robustness analysis (part C) and additional descriptive evidence that provides better contextualization of the key findings (part D).

A. PROGRAMME ACTIVITIES, OUTPUTS AND OUTCOMES

102. The objective of this section is to provide descriptive evidence to assess two aspects: (i) whether the first links of the causal chain required to achieve impacts hold as exposed in the ToC (see section IV for details on the ToC) – in other words whether programme activities produce the intended outputs and outcomes; and (ii) whether phase-in programme implementation complied with the impact evaluation design. Table VI–1 reports the relevant descriptive statistics (mean and standard deviation [SD] split by treatment status, t-test for difference in means) on programme activities, outputs and outcomes (measured at endline after project implementation in Phase 1 UPs).

1. ACTIVITIES

103. The creation of new WLGs with project beneficiaries constitutes a key aspect of the success of the livelihood project component. As members of WLGs, beneficiaries received training sessions on and inputs for the adoption of climate-adaptive livelihoods. After the end of project implementation, the awareness of the existence of WLGs is almost universal in the treatment group (98.4 per cent) and almost non-existent in the control group (3.1 per cent).
104. Awareness is closely linked to actual participation in the WLGs: The likelihood of having a woman in the household who is a member of such a group shows the same pattern, with 87.2 per cent in treatment and 1.7 per cent in the control group. This difference in WLG membership is of large magnitude (1 per cent significance level) and indicates that the randomization protocol (phase-in RCT design) was followed by the implementing partner, with WLG activities happening almost exclusively in Phase 1 UPs.

2. OUTPUTS

105. In line with previous results, respondents at the endline in Phase 1 UP (98.3 per cent) are 95 pp more likely than Phase 2 UP (3.9 per cent) respondents to be aware of what “climate-adaptive livelihoods” are, and of which specific livelihoods are promoted by the programme. Similarly, treatment households (98.2 per cent) are 96 pp more likely (comparison: 2.8 per cent) to report

having at least one member who attended training on alternative livelihoods. These results indicate that programme implementation complied with the experimental design.

3. Outcomes

106. Outputs have likely translated into expected outcomes. Treatment households (98.3 per cent) are 84 pp more likely than households in control areas (14.3 per cent) to currently practice programme-promoted climate-adaptive livelihoods, one popular example being homestead gardening. The share of beneficiaries involved in at least one adaptive livelihood in the last 12 months is much higher in treatment (91.5 per cent) than comparison households (14.2 per cent). Accordingly, the number of adaptive livelihoods, where the beneficiary was involved, is higher in treatment (1.77) compared to the comparison group (0.17).

107. The essential condition that the intervention translates into a sizeable impact is a high level of programme uptake. The results lend credibility to the experimental design, providing evidence that its integrity was preserved and respected by project implementation. In consequence, ITT estimates presented in the next section will provide (almost) unbiased measures of programme causal impacts.

Table VI–1. Programme activities, output and outcomes

	(1) Treatment		(2) Control		(3) = (1) – (2) Difference
	N	Mean (SD)	N	Mean (SD)	
Project activities					
Respondent aware of WLG (y/n)	1,976	0.984 (0.003)	1,128	0.031 (0.005)	0.953***
Any woman in HH is a member of WLG (y/n)	1,976	0.872 (0.008)	1,128	0.017 (0.004)	0.855***
Project output					
Respondent is aware of climate-adaptive LH (y/n)	1,976	0.983 (0.003)	1,128	0.039 (0.006)	0.944***
Any HH member participated in training on adaptive LH (y/n)	1,976	0.985 (0.003)	1,128	0.020 (0.004)	0.965***
Beneficiary received training on adaptive LH	1,976	0.983 (0.003)	1,128	0.020 (0.004)	0.963***
Beneficiary – # of topics/adaptive LH covered in training	1,943	2.2 (0)	23	2.3 (0.2)	-0.1
Project outcomes					
HH practices adaptive LH promoted by the project (y/n)	1,976	0.983 (0.003)	1,128	0.143 (0.010)	0.841***
Beneficiary involved in at least one adaptive LH	1,976	0.915 (0.006)	1,128	0.142 (0.010)	0.774***
Beneficiary – # of adaptive LH involved in	1,976	1.770 (0.020)	1,128	0.167 (0.013)	1.604***
DW-related outcomes					
At least one HH member affected by waterborne disease (y/n)	1,976	0.552 (0.011)	1,128	0.580 (0.015)	-0.028
At least one child below 5 in HH affected by waterborne disease (y/n)	795	0.325 (0.017)	595	0.247 (0.018)	0.077*

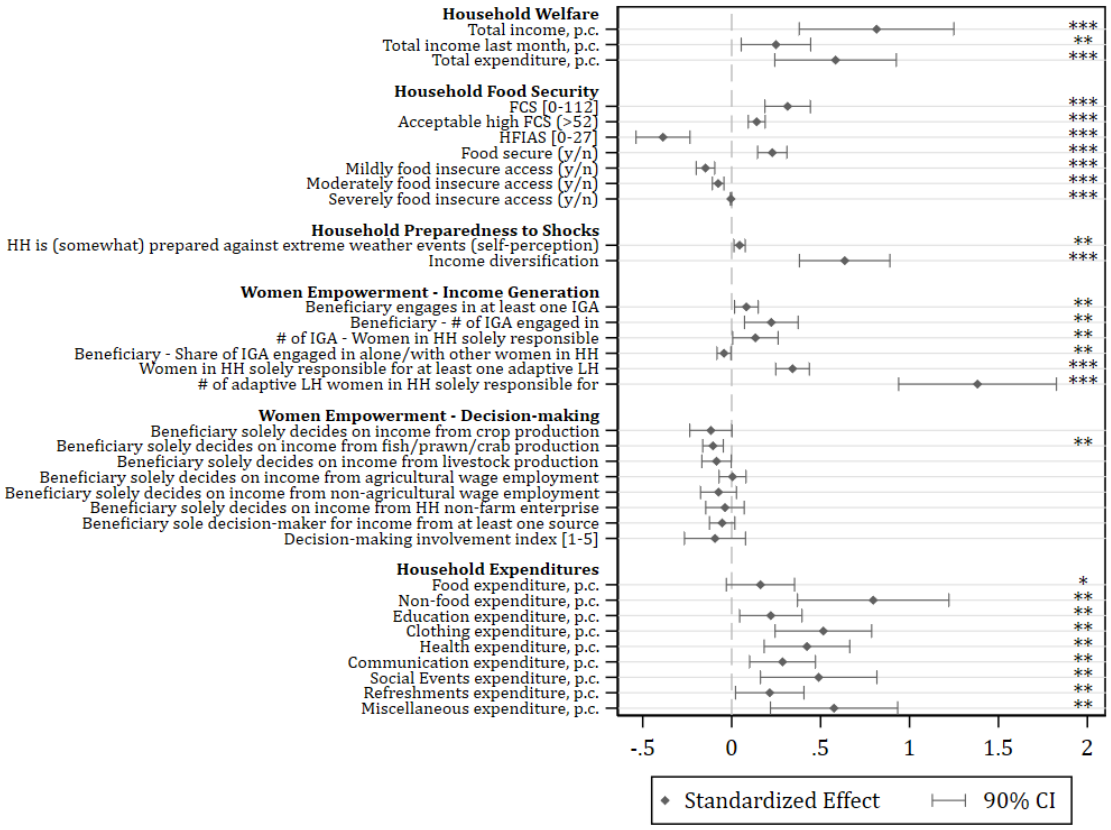
	(1) Treatment		(2) Control		(3) = (1) – (2) Difference
	N	Mean (SD)	N	Mean (SD)	
At least one child aged 6–16 in HH affected by waterborne disease (y/n)	795	0.213 (0.015)	595	0.198 (0.016)	0.014
At least one adult in HH affected by waterborne disease (y/n)	1,976	0.464 (0.011)	1,128	0.477 (0.015)	-0.013
Time spent to fetch water, per week (min)	1,535	350 (7)	807	370 (15)	-19
F-test of joint significance (p-value)					0.935
F-test, number of observations					598

Source: Authors.
Note: p.c. = per capita. Summary statistics based on survey data from 3,120 household interviews. Sixteen outliers are removed, following the method proposed by Crépon and others (2015). SEs are adjusted for clustering at the UP level and stratification on *upazila*. Columns (1) and (2) present the number of observations, means and SDs for the treatment (Phase 1 UPs) and control (Phase 2 UPs) groups, respectively. Column (3) reports the difference in means between the two groups. The significance of this difference is assessed by a simple test of mean equality, adjusting for stratification and clustering. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

B. Programme impacts

108. As per the evaluation design detailed in section V.B, causal programme impacts are measured after eight months of exposure to the livelihood activities (started in Phase 1 UPs in February 2022, endline survey in November 2022) (Figure VI–1). Therefore, the causal analysis captures **short-term** programme impacts and cannot assess their sustainability over time.

Figure VI–1. Programme impacts, at a glance



Source: Authors.
Note: ITT estimates for all outcome variables. Please refer to section V.D for details on the estimation procedure. Each row shows the OLS point estimate and 90 per cent confidence interval. For continuous variables, the effect is expressed in (control group) SD units. Significance is based on "sharpened" q-values. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

1. HOUSEHOLD WELFARE

109. **The average total household income per capita (i.e. per household member) in the last 12 months increased (1 per cent significance level) by over BDT 14,000 (USD 165) in the treatment group compared to the comparison group**.

110. The first group of variables captures household welfare. Table VI–2 reports the ITT estimates for the variables typically understood as proxies for household welfare. The average total household income per capita increased by over BDT 14,000 (USD 165) in the treatment group compared to the comparison group between September 2021 and November 2022 (1 per cent significance level) (row (1)).[37] This corresponds to a 43 per cent increase, given a mean of the outcome of BDT 32,793 (USD 387) in the comparison group. The average total household income per capita in the last month (row (2)) is 26 per cent higher in the treatment than in the comparison group (5 per cent significance level). Row (3) reports the household non-food expenditure per capita prior to endline data collection. It was augmented by BDT 8,463 (USD 100) in the treated household. This corresponds to a 29 per cent increase, given a mean value of BDT 29,321 (USD 346) in the comparison (1 per cent significance level).

[37] We use the average exchange rate of 2021 (BDT 1 = USD 0.0118) to convert currencies from BDT to USD. Source: https://www.exchangerates.org.uk/BDT-USD-spot-exchange-rates-history-2021.html.

Table VI–2. Household welfare – ITT estimates

	ITT	(SE)	CONTROL MEAN	CONTROL SD	NO. OF OBSERVATIONS
Total income, p.c.	14,020***	(4,437)	32,793	17,208	3,099
Total income last month, p.c.	736**	(342)	2,823	2,956	3,099
Total expenditure, p.c.	8,463***	(2,936)	29,321	14,485	3,099

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Significance stars are based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

2. FOOD SECURITY

111. **The Food Consumption Score (FCS) increases by 8 per cent (4.6 units, 1 per cent significance level) in the treatment compared to the comparison group (control mean 54.3).**

112. **The HFIAS reduces by 74 per cent (0.646 units, 1 per cent significance level) in the treatment compared to the comparison group (control mean 0.878).**

113. The evaluation's second set of impact indicators pertains to food security. Table VI–3 presents the ITT estimates for key food security indicators: the FCS and the HFIAS.[38] Higher FCS values indicate increased caloric intake and diet quality, whereas lower HFIAS values signify reduced insecure food access. The findings from the first two outcomes in the table demonstrate the positive effects of the intervention on the FCS: the treatment group showed a 4.6-unit increase (1 per cent significance level) compared to the comparison group (control mean 54.3), corresponding to an 8 per cent change, and a notable 14.1 pp increase (control mean 0.527) for households with an "acceptable high FCS" (>52).

114. The HFIAS in the treatment group reduced by 0.646 units (1 per cent significance level), primarily driven by a significant increase of 22.8 pp in the share of food-secure households and a decrease of 14.7 pp in the share of mildly food-insecure households (both significant at the 1 per cent level). Although the share of moderately and severely food-insecure households also decreased significantly (both at a 1 per cent significance level), the magnitude of change is lower (7.6 and 0.4 pp, respectively). These results provide evidence that the intervention effectively enhances food security among the beneficiary households.

[38] Due to a high correlation between the FCS and the Household Dietary Diversity Score (HDDS), both measures can be used interchangeably for assessing household-level diet dietary. For more information, see https://inddex.nutrition.tufts.edu/data4diets/indicator/household-dietary-diversity-score-hdds.

Table VI–3. Food security – ITT estimates

	ITT	(SE)	CONTROL MEAN	CONTROL SD	NO. OF OBSERVATIONS
FCS [0-112]	4.563***	(1.099)	54.257	14.490	3,104
Acceptable high FCS (>52)	0.141***	(0.028)	0.527	0.500	3,104
HFIAS [0-27]	-0.646***	(0.151)	0.878	1.673	3,104
Food secure (y/n)	0.228***	(0.049)	0.690	0.463	3,104
Mildly food insecure access (y/n)	-0.147***	(0.031)	0.208	0.406	3,104
Moderately food insecure access (y/n)	-0.076***	(0.019)	0.096	0.294	3,104
Severely food insecure access (y/n)	-0.004***	(0.002)	0.006	0.079	3,104

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance stars are based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

3. SHOCK PREPAREDNESS

115. **Programme-assigned beneficiaries exhibit a 4 pp increase (control mean 90.9 per cent) in their perception of household preparedness against future extreme weather events**.

116. The third group of impact indicators in the ToC is related to the preparedness for shocks that in our data corresponds to future extreme weather events such as cyclones, floods and others. The findings presented in Table VI–4 provide insights into the impact of the livelihood programme on self-perceived shock preparedness and income diversification. The empirical analysis reveals that programme-assigned beneficiaries exhibit a 4 pp increase in their perception of household preparedness against future extreme weather events. Although the effect size is relatively small, it is worth noting that the comparison group already had a high mean value of 91 per cent, which may explain the modest change observed. This impact is statistically significant at a 95 per cent confidence level.

117. Furthermore, a measure of income diversity, indicated by the inverse HHI, demonstrates an improvement of 0.59 units (1 per cent significance level) among individuals assigned to the treatment group. Since a higher value of the inverse HHI represents a lower degree of concentration of income generation, the livelihood component caused an increase in income diversification. This result indicates a higher level of preparedness for climate shocks in treatment households by placing income generation on different activities (e.g. adaptive livelihoods promoted by the programme).

Table VI–4. Shock preparedness – ITT estimates

	ITT	(SE)	CONTROL MEAN	CONTROL SD	NO. OF OBSERVATIONS
HH is (somewhat) prepared against extreme weather events (self-perception)	0.045**	(0.019)	0.909	0.288	3,095
Income diversification	0.586***	(0.139)	2.175	0.922	3,104

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance stars are based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

4. WOMEN EMPOWERMENT – INCOME GENERATION

118. **The results indicate improvements in women's empowerment in treated households, where a higher share of women engaged in at least one IGA by 8.3 pp compared to the control group (control mean 68.7 per cent)**.

119. The livelihood programme aimed at empowering women, particularly in the context of income generation, as reflected in Table VI–5. The results indicate improvements in women's empowerment in treated households, where a higher share of women engaged in at least one IGA by 8.3 pp compared to the control group (control mean 68.7 per cent). The ITT estimate (0.257, 5 per cent significance level) in the second row also aligns with this finding, suggesting an increase in the number of IGAs in which programme-assigned women are involved. Notably, the programme led to a rise in the number of IGAs for which women in the household were solely responsible (5 per cent significance level), whereas the share of IGAs where the beneficiary engaged alone or with other women decreased in treated households (5 per cent significance level).

120. Furthermore, the livelihood programme demonstrated substantial positive effects on women's empowerment in adaptive livelihoods, with the share of women solely responsible for at least one adaptive livelihood increasing by 34.2 pp (1 per cent significance level). Additionally, the number of adaptive livelihoods for which women in the household took sole responsibility also increased by 50 pp (1 per cent significance level).

Table VI–5. Women empowerment – income generation – ITT estimates

	ITT	(SE)	Control mean	Control SD	No. of observations
Beneficiary engages in at least one IGA	0.083**	(0.039)	0.687	0.464	3,088
Beneficiary – # of IGA engaged in	0.257**	(0.103)	1.235	1.154	3,088
# of IGA – Women in HH are solely responsible	0.139**	(0.079)	1.008	1.042	3,088
Beneficiary – Share of IGA engaged in alone/with other women in HH	-0.043**	(0.023)	0.830	0.316	2,234
Women in HH solely responsible for at least one adaptive LH	0.342***	(0.056)	0.101	0.302	3,104
# of adaptive LH women in HH solely responsible for	0.510***	(0.097)	0.113	0.369	3,104

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance is based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

5. Women empowerment – decision-making

121. **The results do not indicate an increase in women's empowerment for decision-making**.

122. Table VI–6 presents the findings related to women's empowerment in decision-making within the household in various categories of decision-making on income: from crop production, fish/prawn/crab production, livestock production, agricultural and non-agricultural wage employment, household non-farm enterprise, or if a woman is a sole decision maker for income from at least one source. We also present the results for the decision-making involvement index, ranging from 1 to 5.[39]

123. Overall, the results do not indicate an increase in women's empowerment for decision-making, as the coefficients for all variables are negative and mostly non-significant (except for "Beneficiary solely decides on income from fish/prawn/crab production", which is statistically significant at the 5 per cent level). One plausible explanation for the negative effects in the treatment group concerning fish/prawn/crab production could be attributed to the lucrative nature of this livelihood option, which could have led to shared responsibilities among household members for income generation.

124. Moreover, so far, we have captured short-term effects only, and achieving a shift in deeply ingrained attitudes such as gender roles requires time, possibly only detectable in the longer term. Further

[39] Decision-making involvement index: the index is based on questions asked to the beneficiary (always a woman) of the form "Which of these statements reflects best the extent to which you could decide how the income from [income source] over the past 12 months was spent/used?" There are six income sources, hence six questions (crop production, fish/prawn/crab production, livestock production, agricultural wage employment, wage employment in non-agricultural activities, and household non-farm enterprises). Each question has the following answer options: 1 = Full; 2 = Maximum; 3 = Fifty-fifty; 4 = Little; 5 = None. That is, lower values indicate a higher level of control over the decision-making process. To calculate the index, the reversed scale was used (so that a higher value indicates a higher level of control for the beneficiary) and averaged over the six questions. Hence, the decision-making involvement index ranges between 1 (i.e. absolutely no control over decisions on how to manage income, irrespective of income source) and 5 (i.e. full control over income from all sources).

exploration would have been necessary to comprehend the true impact of the intervention on women's empowerment in decision-making, which will, however, be impossible with a phase-in design.

Table VI–6. Women empowerment – decision-making – ITT estimates

	ITT	(SE)	Control mean	Control SD	No. of observations
Beneficiary solely decides on income from crop production	-0.117	(0.070)	0.301	0.460	960
Beneficiary solely decides on income from fish/prawn/crab production	-0.105**	(0.034)	0.176	0.382	471
Beneficiary solely decides on income from livestock production	-0.085	(0.049)	0.307	0.462	1,631
Beneficiary solely decides on income from agricultural wage employment	0.005	(0.045)	0.269	0.445	416
Beneficiary solely decides on income from non-agricultural wage employment	-0.074	(0.060)	0.341	0.475	418
Beneficiary solely decides on income from HH non-farm enterprise	-0.038	(0.064)	0.284	0.453	292
Beneficiary sole decision maker for income from at least one source	-0.053	(0.042)	0.329	0.470	2,234
Decision-making involvement index [1-5]	-0.116	(0.126)	3.476	1.239	2,233

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance is based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: ** $p < 0.05$.

6. Household expenditure

125. As reported in Table VI–2, household expenditures, both on food and non-food items, increased in treatment households. Table VI–7, reporting the effect of the livelihood programme on different kinds of household expenditures, allows us to investigate what items the money was spent on. The per capita non-food expenditures are of higher magnitude (6,727 vs. 1,460) and significance (5 per cent vs. 10 per cent significance level) than for food.

126. It may seem surprising that food expenditure increased less than non-food expenditure, given the higher household food security. However, at the endline 71 per cent of treated households were engaged in homestead gardening and 52 per cent in aqua-geoponics,[40] two livelihood options encouraged by the programme. Both livelihood options can directly improve food production. Consequently, households have the resources left to spend the additional money from increased income on non-food expenditure.

[40] A concept within the integrated farming system approach for producing fish and vegetables in floating condition where waste materials (fish faeces and unused feed) from fish culture dissolved in the pond water and settled in the bottom mud layer are then used for vegetable production.

127. All impact estimates of non-food items are positive. The highest percentage increase in expenditures with regard to the comparison household are social events expenditures (129 per cent, statistically significant at the 5 per cent level), miscellaneous expenditures (126 per cent, statistically significant at the 5 per cent level) and health expenditures (55 per cent, statistically significant at the 5 per cent level).[41]

Table VI–7. Household expenditure – ITT estimates

	ITT	(SE)	Control mean	Control SD	No. of observations
Food expenditure, p.c.	1,460*	(1,026)	19,179	9,022	3,099
Non-food expenditure, p.c.	6,727**	(2,135)	10,138	8,453	3,099
Education expenditure, p.c.	426**	(201)	1,405	1,936	3,099
Clothing expenditure, p.c.	425**	(133)	1,478	824	3,099
Health expenditure, p.c.	1,329**	(448)	2,255	3,140	3,099
Communication expenditure, p.c.	322**	(124)	981	1,126	3,099
Social events expenditure, p.c.	821**	(326)	634	1,677	3,099
Refreshments expenditure, p.c.	223**	(119)	930	1,041	3,099
Miscellaneous expenditure, p.c.	3,112**	(1,147)	2,455	5,404	3,099

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance stars are based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

C. Robustness checks

1. Attrition

128. To investigate how attrition may affect the results, the analysis is repeated for all 37 outcomes by adding to regression specification (1) an interaction term between the treatment assignment variable and a dummy variable that equals 1 if a household is a replacement household. Results from Table A - 8 indicate that the interaction effect is only significant in one out of 37 cases (variable "Beneficiary solely decides on income from non-agricultural wage employment"). Consequently, we conclude that results from the main analysis are most likely not driven by attrition.

2. Outliers

129. We test the sensitivity of our results to outliers by repeating the main analysis after using the trimming algorithm described in section V.C to remove 1 per cent, 2 per cent and 5 per cent of observations. Results from Table A - 9 show that the impact estimates from the main analysis are qualitatively stable when trimming a larger share of observations. The sign, magnitude and

[41] Miscellaneous expenditures: anything that was not reported by the household in the other categories. In other words, total non-food expenditures = education + clothing + health + communication + social events + refreshments + miscellaneous.

significance of impact estimates remain very similar across the board, with two exceptions when trimming 5 per cent of observations: outcome "Severely food insecure access", where the coefficient is virtually 0 and becomes insignificant (versus a small negative ITT estimate in the main analysis of -0.004 significant at the 5 per cent level); and outcome "Beneficiary solely decides on income from agricultural wage employment", where the coefficient estimate exhibits a sign reversal but remains very small in magnitude and insignificant (as in the main analysis). Finally, the larger the share of trimmed observations, the lower the magnitude of ITT estimates for household income and expenditure outcomes. This pattern is not surprising, as such variables are known to be right-skewed. The largest drop in magnitude is observed when trimming 5 per cent of observations, which is a conservative scenario. Only in three cases does the ITT estimate also lose significance (for expenditures on food, education and refreshments). Overall, we are confident that the results from the main analysis are not heavily biased by outliers.

3. Randomization inference

130. Randomization inference is an alternative approach to gauging the statistical significance of impact estimates (see section V.D for methodological details). Results are shown in Table A - 10 as well as the Figure A - 2. The significance of impact estimates for variables proxying household welfare is weaker, but only the impact measured on "Total income per capita last month" becomes insignificant (significant at 5 per cent in the main analysis). Results on food security and household preparedness for shocks remain qualitatively similar to the main results. However, most impact estimates for outcomes measuring women's involvement in household IGA become insignificant, with the exception of two outcomes ("Number of IGA the beneficiary engages in" and "Number of IGA in household for which women are solely responsible"). Conversely, four out of eight women's decision-making outcomes exhibit a significant negative impact when using randomization inference (against only one in the main analysis). These results somewhat mitigate the results from the main analysis, hinting that the programme has no clear impact on women's empowerment. Finally, impacts measured on household expenditure variables become insignificant for four such outcomes (expenditures on food, education, social events and refreshments), whereas all are significant in the main analysis. Nonetheless, the large positive impacts measured for non-food expenditure, expenditures on clothing, education and health, remain significant.
131. Overall, results from randomization inference confirm some of the key findings of the main analysis in terms of positive programme impacts on household welfare and non-food expenditure, as well as on food security and preparedness for shocks. The picture is more mixed for women empowerment outcomes, and the results seem to hint that the programme does not have a clear impact on this dimension.

D. Additional descriptive analysis of possible mechanisms

1. Income sources

132. Table VI–2 shows that households in the treatment group benefited from an increase in total annual income due to the treatment. The total annual income is an aggregated measure from different income sources. Exploiting those different income sources, we shed further light on possible structural changes in the composition of households' income. We apply a t-test for differences in mean income shares between the treatment and comparison group at endline.
133. Table VI–8 reports that the mean income shares from crop production (1.6 pp), livestock production (1.9 pp, 5 per cent significance level) and other sources (e.g. daily or seasonal work) (2 pp, 5 per

cent significance level) are higher in the treatment compared to the comparison group. On the other hand, the mean income shares from agricultural (2.3 pp) and non-agricultural (3.7 pp) wage employment are lower in the treatment than in the comparison group. It seems that households might have restructured their income source by substituting wage employment with self-employment, including agricultural work. This might be seen as a substitution from a more rigid to a more flexible income model.[42]

Table VI–8. Income shares from different income sources

	(1) Treatment		(2) Control		(3) = (1) – (2) Difference
	N	Mean (SD)	N	Mean (SD)	
Income share from crop production	1,992	0.087 (0.003)	1,128	0.070 (0.004)	0.016
Income share from fish/shrimp/crab production	1,992	0.093 (0.004)	1,128	0.092 (0.006)	0.001
Income share from livestock production	1,992	0.066 (0.002)	1,128	0.047 (0.003)	0.019**
Income share from agricultural wage employment	1,992	0.169 (0.005)	1,128	0.192 (0.008)	-0.023
Income share from non-agricultural wage employment	1,992	0.319 (0.006)	1,128	0.357 (0.010)	-0.037
Income share from non-farm HH enterprises	1,992	0.094 (0.005)	1,128	0.094 (0.007)	0
Income share from transfers	1,992	0.037 (0.002)	1,128	0.033 (0.003)	0.004
Income share from other sources	1,992	0.136 (0.004)	1,128	0.115 (0.005)	0.020**

Source: Authors.
Note: Summary statistics based on survey data from 3,120 household interviews. Sixteen outliers are removed, following the method proposed in Crépon and others (2015). SEs are adjusted for clustering at UP level and stratification on *upazila*. Columns (1) and (2) present the number of observations, means and SDs for the treatment (Phase 1 UPs) and control (Phase 2 UPs) groups, respectively. Column (3) reports the difference in means between the two groups. The significance of this difference is assessed by a simple test of mean equality, adjusting for stratification and clustering. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

2. Drinking water component

134. Drinking water solutions were implemented in parallel to the adaptive livelihood component of the project. The 13,308 household-based RWHS initially planned by the project were constructed between November 2021 and March 2022, and were expected to be fully functional when the rainy season started in June 2022. As of October 2022 (i.e. when endline data were collected), the project had delivered 26 community-based RWHS (out of the 288 planned) serving a total of 2,361 households (please refer to section III for details on drinking water solutions).

135. In the study sample, Table VI–9 shows that about half the households have access to one of the drinking water solutions offered by the project. For close to 46 per cent of study households, the project provides drinking water support through household-based RWHS, with very similar

[42] These results are only descriptive evidence and do not represent any causal relationship. Also, the observed differences in mean income shares are of small magnitude and statistical significance, limiting their meaningfulness.

coverage in the treatment and control study groups. Less than 5 per cent of households in the sample are covered by community-based RWHS, with slightly broader coverage in the treatment (5.1 per cent) than in the control group (3.3 per cent). The project team notes that the 1,545 study households not yet covered by drinking water solutions will all benefit from access to the community-based RWHS under construction.

Table VI–9. Drinking water solutions in the study sample

	Treatment group N / (%)	Control group N / (%)	Total N / (%)
Number of households with household-based RWHS	913 (46.2%)	509 (45.1%)	1,422 (45.8%)
Number of households with access to community-based RWHS	100 (5.1%)	37 (3.3%)	137 (4.4%)
Number of households with no access to drinking water solutions	963 (48.7%)	582 (51.6%)	1,545 (49.8%)
Total number of study households	1,976	1,128	3,104

Source: Authors, based on project monitoring data and survey data.

136. The key mechanism described in section IV stipulates that women in households benefiting from drinking water solutions should be able to reallocate time away from fetching water towards IGA – in particular, the adaptive livelihoods promoted by the project. The descriptive statistics shown in Table VI–10 do not provide evidence that this may be the case. Indeed, there is no statistically significant difference in terms of time allocated to fetching water or of involvement in household IGA between households benefiting from household-based RWHS and those who do not.[43]

[43] Note the households having access from community-based RWHS are grouped with households who do not have access to any drinking water solutions. We argue defining the groups this way does not bias the comparison for two reasons. First, there a few households with access to community-based RWHS in the study sample. Second, the gains from having access to community-based RWHS are expected to be marginal compared to the gains from having a RWHS on the home compound. In practice, the numbers are almost identical when excluding this group from the comparison (available from the authors upon request).

Table VI–10. Time allocation and household-based RWHS

	(1) HH-BASED RWHS		(2) NO HH-BASED RWHS		(1) - (2) T-TEST DIFFERENCE
	N / CLUSTERS	MEAN (SE)	N / CLUSTERS	MEAN (SE)	
Fetching water and household chores					
Time spent to fetch water, per week (min)	948 (38)	344.7 (9.5)	1,394 (39)	365.3 (9.7)	-20.5
Beneficiary – Time spent fetching water per fetch (min)	632 (38)	47.4 (1.1)	952 (39)	43.8 (1)	3.6
Beneficiary – Time spent on HH chores and unpaid care work, hours per day	1,422 (38)	6.6 (0.1)	1,682 (39)	6.7 (0)	-0.1
Involvement in IGA					
Beneficiary – # of IGA engaged in	1,413 (38)	1.3 (0)	1,675 (39)	1.4 (0)	-0
Beneficiary – Time spent on HH IGA, hours per day	1,422 (38)	3.9 (0.1)	1,682 (39)	4.1 (0.1)	-0.1
Beneficiary – Time spent on adaptive LH, hours per day	1,422 (38)	2.9 (0.1)	1,682 (39)	2.5 (0.1)	0.3

Source: Survey data and authors' computations.
Note: The table presents summary statistics on 3,104 study households. SEs are adjusted for clustering at UP level and stratification at the *upazila* level. Column (1) presents the number of treatment households and clusters, column (2) presents the UP-clustered means and respective SEs of the treatment households, column (3) presents the number of control households and clusters, column (4) presents the UP-clustered means and respective SEs of the control households, column (5) presents the value for t-tests of the difference in means across treatment and control groups. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

137. Descriptive evidence from Table VI–11 adds that there is also no statistically significant difference in time allocated to fetching water or to household chores between experimental groups. However, treatment group beneficiaries are involved in more numerous IGAs and spend substantially more time on adaptive livelihoods than their control-group counterparts, while beneficiaries in both groups report spending a similar amount of time on IGA overall.

Table VI–11. Time allocation – by treatment assignment

	(1) TREATMENT		(2) CONTROL		(1) – (2) T-TEST DIFFERENCE
	N / CLUSTERS	MEAN (SE)	N / CLUSTERS	MEAN (SE)	
Fetching water and household chores					
Time spent to fetch water, per week (min)	1,535 (25)	350.3 (7.1)	807 (14)	369.6 (15)	-19.2
Beneficiary – Time spent fetching water per fetch (min)	1,106 (25)	44.7 (0.8)	478 (14)	46.5 (1.5)	-1.7
Beneficiary – Time spent on HH chores and unpaid care work, hours per day	1,976 (25)	6.6 (0)	1,128 (14)	6.6 (0.1)	0.1

	(1) Treatment		(2) Control		(1) – (2) T-test difference
	N / clusters	Mean (SE)	N / clusters	Mean (SE)	
Involvement in IGA					
Beneficiary – # of IGA engaged in	1,967 (25)	1.4 (0)	1,121 (14)	1.2 (0)	0.2**
Beneficiary – Time spent on HH IGA, hours per day	1,976 (25)	4.1 (0.1)	1,128 (14)	3.8 (0.1)	0.3
Beneficiary – Time spent on adaptive LH, hours per day	1,976 (25)	4 (0.1)	1,128 (14)	0.4 (0)	3.7***

Source: Survey data and authors' computations.
Note: The table presents summary statistics on 3,104 study households. SEs are adjusted for clustering at UP level and stratification at the *upazila* level. Column (1) presents the number of treatment households and clusters, column (2) presents the UP-clustered means and respective SEs of the treatment households, column (3) presents the number of control households and clusters, column (4) presents the UP-clustered means and respective SEs of the control households, column (5) presents the value for t-tests of the difference in means across treatment and control groups. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

138. While the tentative evidence provided here suggests the key mechanism highlighted in the ToC may not be working, we suggest caution regarding this conclusion. Rather, the observed patterns likely reflect the fact that when households were interviewed at endline, they had not yet experienced a dry season with the full advantage of the newly built RWHS, as it did not rain enough after their construction.[44] Therefore, endline data on time allocated to fetching water likely reflects the situation as it was without household-based RWHS, and the time reallocation mechanism intended by the project simply did not yet have the chance to materialize.

139. Hence, how do women get involved in adaptive livelihoods if they do not free up time from fetching water and doing household chores? The descriptive evidence from Table VI–11 suggests that time reallocation may be happening across IGAs. Indeed, beneficiaries in both experimental groups report spending similar amounts of time on IGA in general, but only those in the treatment group spend a substantial amount of time on adaptive livelihoods. Therefore, it is possible that women in the latter group divert time away from some of the IGAs they were previously involved in, in order to take up adaptive livelihoods, which is also in line with beneficiaries in the treatment group being involved in more numerous IGAs in general.

3. The role of input support

140. The input support was an in-kind support of the necessary inputs for realizing the selected adaptive livelihoods. It was delivered for each WLG at the beginning of the first three production cycles of the selected adaptive livelihood options. Thus, all WLGs in the treatment group should have benefited from the input support before the endline data collection was conducted. However, monitoring and information system (MIS) data show that 8.6 per cent of households in the treatment group (N=251) had not yet benefited from the input support. Two major reasons were non-availability of suitable land for production and seasonality.

[44] RWHS are designed to fill during the rainy season, to provide clean drinking water to households during the dry season. In other words, the drinking water component of the project is designed to generate gains in terms of fetching water during the dry season. Consequently, survey questions on time allocation to fetching water are asked with respect to the dry season. However, endline data were collected in October 2022, and household-based RWHS were built between November 2021 and March 2022 – that is, during the dry season (the rain season in Bangladesh typically lasts from June to October).

141. The provided input support comprehensively covered all expenses related to the livelihood programme. The major asset covered with the input support was the leasing of land and ponds. This is not surprising given the adaptive livelihood options. The three most selected climate-adaptive livelihoods of WLGs in the endline sample are homestead gardening (34.1 per cent), aqua-geoponics (29.6 per cent) and hydroponics (16.6 per cent). The same pattern holds for the sample with all WLGs. Since for these three livelihoods, one production cycle lasts four months, the first production cycle was finished before the endline data collection.

142. The average size of WLGs in the endline sample was 25.3 women, which is close to the average size of 24.7 women for all 1,020 WLGs. In both cases, the sizes ranged from 10 to 35 women.[45] The average input support per household in monetary terms in the endline sample was BDT 4,701.[46] This equals 3 per cent of the annual total household income in the endline sample.

143. The statistically significant increase in household welfare might be driven by the input support. Please remember that the measured ITT estimates capture short-term effects only, a few months after the start of the adaptive livelihood programme. Given that all expenses in the first production cycle were covered by the input support, the treated households incurred no costs associated with the selected livelihood option.

144. To investigate how much of the households' total annual income can be explained by the input support received per household, we ran a simple OLS regression with input support per household as an explanatory variable and household total annual income as a dependent variable.[47] Table VI–12 reports the results: there is no statistically significant relationship between the input support and the annual total income.

Table VI–12. Input support and total annual household income

	ITT	(SE)	No. of observations
Total income	3.342	(2.292)	2,917

Source: Survey data, MIS data and authors' computations.
Note: ITT estimate from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables. SEs are clustered at the UP level and reported in parentheses.

145. While input support has certainly played an important role by covering all livelihood-related expenses in the first production cycle, the results suggest that the role of input support in explaining the statistically significant increase in household welfare is minor. Thus, further analysis is needed to reveal the mechanisms behind the increase in household welfare.

[45] Due to data issues in the MIS data, we have information about input support for 2,917 households (out of 3,120) in our endline sample.
[46] For this, the input support for each WLG was divided by the number of members of the respective WLG. We assume that each group member benefited equally from the input support. Computations are based on the latest available MIS data (July 2023).
[47] The regression also includes randomization strata (*upazila*) dummy variables, and SEs are clustered at the UP level.

VII. CONCLUSION

146. The objective of this impact evaluation was to assess the impact of a livelihood support programme that was implemented by UNDP and that especially targeted women in south-western Bangladesh. The intervention aimed to enhance the socioeconomic status and resilience of women to climate change by providing them with training, resources and financial support to start IGAs.

147. The impact evaluation results indicate a significant positive impact on women's economic conditions. The livelihood support programme facilitated income diversification, enabling women to engage in various agricultural activities. As a result, women reported increased income: the average total household income per capita (i.e. per household member) in the last 12 months significantly increased by over BDT 14,000 (USD 252) in the intervention group.

148. The project's interventions also positively influenced the socioeconomic conditions of participating women and their households. The increased income and economic opportunities created a ripple effect, leading to increased household expenditures and improved food security. For example, the FCS significantly increased by 8 per cent (4.6 units) in the treatment compared to the comparison group (control mean 54.3). When we look at the alternative measure of food security, the HFIAS significantly reduced by 74 per cent (0.646 units) in the treatment compared to the comparison group (control mean 0.878).

149. The evaluation finds no evidence for key empowerment-related outcomes. Women in the programme group were not more likely to report increased involvement in household decision-making processes as compared to women in the control group. Yet these outcomes are measured shortly after the intervention ended and the duration may have been insufficient to change deeply rooted gender norms in Bangladesh. Later measurements and alternative measures of women's empowerment should be utilized for the analysis in future.

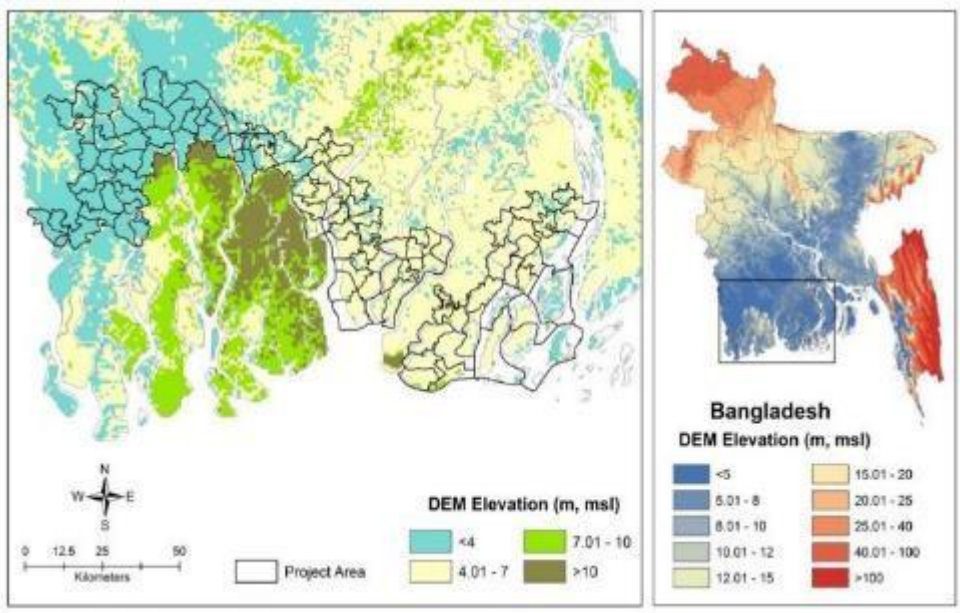
150. It is important to acknowledge challenges faced during the impact evaluation: First, the report focuses on short-term effects measured after only one year of exposure to the programme, which limits information on the sustainability of impacts. Second, the design does not allow for causal exploration of mechanisms that empower women in addition to livelihood support. Third, the information was not triangulated with insights from qualitative data collections.

151. In conclusion, the livelihood support intervention for women in southern Bangladesh had a positive impact on women's economic standing and other welfare measures. The project successfully improved income generation and increased food security. Going forward, implementing agencies may consider scaling up, replicating and studying these interventions in different settings and exploring the long-term impacts.

APPENDIX. SUPPLEMENTARY ANALYSIS

Project location and overview of M&E activities

Figure A - 1. Elevation levels in Bangladesh



Source: Green Climate Fund (2018)

Table A - 1. Overview of implementation and M&E activities

Component	Activity	Status in treatment areas	Status in comparison areas
LH	WLG formation	Completed	Completed
LH	Ward-level LH profiling	Completed	Completed
LH	Training of trainers on adaptive LHs	Completed	Completed
LH	Gender–climate nexus training of trainers for MoWCA	Central level	Central level
LH	Training on adaptive LHs for beneficiaries	Completed	Completed
LH	Input distribution for adaptive LHs for beneficiaries	Completed	Completed
DW	Community- and institution-based RWHS installation (pilot)	Completed	6 UPs
DW	Consultation meeting on fee-based modelling for community-, institution- or pond-based RWHS	Completed	Completed
DW	Water quality testing for HH RWHS	Completed	Completed
M&E	Census data collection	Completed	Completed
M&E	Beneficiary selection and verification	Completed	Completed
M&E	Baseline data collection	Completed	Completed

Component	Activity	Status in treatment areas	Status in comparison areas
M&E	Development of a monitoring system	Completed	Completed
Overall	Village and community-specific mapping, participatory planning	Completed	Completed
Overall	Market actor mapping	Completed	Completed

Source: Authors.
Note: M&E = monitoring and evaluation, MoWCA = Ministry of Women and Children Affairs

Sample distribution at baseline

UNDP carried out a full census of the households living in the project areas to collect the information needed to compute the vulnerability scores that determine the households' eligibility to receive the programme activities. Beneficiary lists were finalized in September 2021, after validation in the field by UNDP. The impact evaluation team used said lists to select the baseline survey sample.

Before selecting the beneficiaries to interview at baseline, the sampling frames were cleaned as follows:

- Duplicates in unique household identification numbers were dropped.
- Duplicates in national identification numbers were dropped.
- Seemingly erroneous national identification numbers were dropped.
- Households that could not match the census data were dropped.

Table A - 2 shows the distribution of households per cluster (one cluster is defined as one UP) as per the baseline data for the sample of households that were observed.

Table A - 2. Number of contacted households per cluster at baseline

Group	No. of clusters	Min.	Mean	Max.
Control	5	160	224	320
Treatment	5	240	400	480

Source: Authors.
Note: One cluster is defined as one UP. Five UPs are Assasumi, Dacope, Koyra, Paikgachha and Shyamnagar.

Software and code

To conduct the impact evaluation various software were utilized. For the drafting of the questionnaires, MS Excel was used. The survey was conducted through computer-assisted personal interview on a tablet. KoBoToolBox programming was provided by the UNDP team. For statistical analysis, Stata was used. Table A - 3 contains a full list of the software used and their purpose.

Table A - 3. List of software used in the impact evaluation

SOFTWARE	PURPOSE	PROJECT OBJECTS DERIVED
MS Excel	• Creation of questionnaires • Quality checks during data collection • Cleaning the sampled farmer listing of the households • Programming the household questionnaire to feed into computer-assisted personal interview	• Cleaned farmer listing, programmed version of the endline questionnaire • Codebook, questionnaires • Raw data set
ODK & KoBoToolBox	Electronic and mobile data collection	Raw data sets
Stata	Data cleaning, management and statistical analysis	Do-files, log files, raw data set, cleaned data sets

Source: Authors.

Power calculations and baseline sample size

The sample size targeted at baseline was informed by power calculations performed by the LORTA team. Power calculations broadly refer to a set of formulas used to compute the minimum sample size required to detect the impacts of a project in an experimental set-up.

The team used the following power formula for clustered randomization designs that relates the sample size to the minimum detectable effect size (MDES) (i.e. the expected difference in mean outcomes between the treatment and comparison groups):

$$MDE = (t_{1-\kappa} + t_{\alpha}) \sqrt{\frac{1}{P(1-P)}} \sqrt{1 + ICC(m-1)} \sqrt{\frac{\sigma^2}{N}} \sqrt{1-R^2}$$

where $t_{1-\kappa}$ and t_{α} are t-statistics representing the required power and level of statistical significance (by convention, we seek the power of 80 per cent[48] and a statistical significance of 5 per cent[49]), P represents the proportion in one of the two compared groups (allocation ratio), ICC is the intra-cluster correlation (UP-level intro-cluster correlation),[50] m is the number of households per cluster, σ^2 is the variance of the outcome variable of interest, N is the total sample size, and R^2 represents the extent to which baseline characteristics predict the endline outcome variable.

The key outcome of interest is a household's annual income. Statistics for household annual income have been obtained from a previous survey, carried out by Practical Action Consulting in 2019 in the project areas. The survey collected information on the households' monthly average income and their primary and secondary sources of income. Because of inconsistencies in the data on secondary income, only the primary income was considered for the power calculations. Furthermore, the primary income variable exhibited unlikely extreme observations.[51] Therefore, the bottom 1 per cent of observations were trimmed and the variable was winsorized at 99 per cent before the variable was

[48] This is the probability of correctly concluding that an intervention has an effect. It is commonly set at 80 per cent in social sciences.
[49] This is the probability of a false-positive result: the chance that a result shows that a treatment has an impact when in reality it does not. A broadly accepted threshold in the impact evaluation literature is 5 per cent.
[50] It is important to account for clustering when performing power calculations. The reason is that we expect the behaviours and hence the outcomes of beneficiaries (and non-beneficiaries) to be significantly correlated when they belong to the same cluster. This phenomenon is measured by the ICC: the higher the ICC, the lower the informational value of an extra observation from the same cluster. In other words, the ICC (that exists because of clustering) depreciates information, and this depreciation must be compensated for by either increasing the sample size, accepting a lower statistical precision, or considering a larger treatment effect size.
[51] The survey reported some households earning BDT 0 per month from their primary income source, while some others reported earning as much as BDT 200,000 per month, or about USD 2,350.

multiplied by 12 to get an estimate of yearly household income. Statistics for household annual income are as follows:

- The mean annual household income is BDT 90,530.
- The SD is BDT 55,233.
- The UP-level intra-cluster correlation is 0.054.

Based on the project's economic analysis, we expected that the project components would lead to an increase in time allocation to diverse livelihoods and, with that, higher income for the beneficiaries. We considered the project to cause an increase in income of 15 per cent (with an endline average income of BDT 104,109.5 in the treatment group). In other words, at the endline, we expected to observe a difference between the average annual income of beneficiary and control households to be around BDT 13,579.5, which corresponds to a 15 per cent change from a baseline annual income of BDT 90,530.

The standardized minimum detectable effect size (MDES) is expressed in terms of the number of SDs and is calculated below:

$$Standardized\ MDES\ = \frac{MDE}{SD} = \frac{90{,}530}{55{,}233} = 1.64\ SD$$

The power calculations assumed there to be 25 clusters in the treatment group (Phase 1 UPs) and 14 clusters in the control group (Phase 2 UPs), in line with the randomization design. Results indicated that through the measurement of 68 households' annual income in each cluster at endline an impact of a 14.9 per cent increase in income, in respect to the control group, was to be measured. These results are presented below in Table A - 4. Based on these, the impact evaluation team adjusted for an attrition rate of 15 per cent and agreed on a target sample size of 3,120 observations, equally split across UPs.

Table A - 4. Sample size calculations based on income as the outcome variable

Baseline income (BDT)	Endline No. of HHs per cluster	Baseline No. of HHs per cluster (corrected for attrition)	Baseline total No. of HHs	MDES	Endline income (BDT)
90,530	68	80	3,120	+14.9%	103,991

Source: Authors' calculations using baseline data from project areas.
Notes: MDES = minimum detectable effect size. The cluster size refers to the number of households to be surveyed – on average – in each of the 39 clusters.

Table A - 5. Balance test results

VARIABLE	(1) TREATMENT		(2) CONTROL		(1) – (2) T-TEST DIFFERENCE
	N [CLUSTERS]	MEAN (SE)	N [CLUSTERS]	MEAN (SE)	
Own (Who is the owner of this water source?)	42,667 [25]	0.159 (0.021)	23,218 [14]	0.173 (0.033)	–0.014
Own (Who is the owner of the land where you are residing?)	42,930 [25]	0.474 (0.018)	23,299 [14]	0.520 (0.037)	–0.046
Close (What is the distance between the drinking water source and your house?)	42,933 [25]	0.688 (0.036)	23,301 [14]	0.654 (0.049)	0.034
Yearly (How frequently does salinity happen here?)	27,007 [25]	0.803 (0.035)	15,607 [14]	0.780 (0.077)	0.023
Have you heard about the term “climate change”?	42,489 [25]	0.725 (0.033)	23,187 [14]	0.718 (0.063)	0.007
No disease in the last year (Health condition of the head of HH)	42,933 [25]	0.192 (0.026)	23,301 [14]	0.158 (0.022)	0.034
Do you have food stock at your home?	42,929 [25]	0.830 (0.026)	23,300 [14]	0.809 (0.023)	0.021
Do you make any savings to meet the treatment cost during a disaster?	42,821 [25]	0.192 (0.017)	23,279 [14]	0.211 (0.019)	–0.019
Average monthly income of the HH from various sources	42,933 [25]	8,798 (344)	23,301 [14]	9,303 (244)	–506
Agriculture/fishing day labour (Main source of income of the HH)	42,872 [25]	0.239 (0.021)	23,281 [14]	0.226 (0.030)	0.014
Do female members of the HH face difficulties in collecting water?	39,112 [25]	0.162 (0.022)	20,357 [14]	0.129 (0.020)	0.034
Are you or anyone in your HH a member of a safety net programme?	42,911 [25]	0.445 (0.038)	23,298 [14]	0.481 (0.075)	–0.036
Did you face difficulties in managing food for the HH members due to a disaster?	42,918 [25]	0.760 (0.023)	23,297 [14]	0.704 (0.026)	0.056
No. of people in the census at the *union parishad* level	42,933 [25]	2,501 (174)	23,301 [14]	2,382 (418)	120
F-test of joint significance (p-value)					0.280
F-test, number of observations					37,505

Source: Authors.
Notes: The value displayed for t-tests is the difference in means across groups. The value displayed for the F-test of joint significance is the p-value. SEs are adjusted for clustering at UP level and stratification on *upazila*.

Attrition analysis

Table A - 6. Regression of attrition dummy variable on treatment status, relevant baseline characteristics, and their interaction

	RESPONDENT ATTRITTED BETWEEN BASELINE AND ENDLINE SURVEY
Treatment	0.012 (0.074)
HH head – Age (in years)	-0.001 (0.001)
HH head – Married (y/n)=1	-0.056 (0.064)
HH head – Gender (Male = 1) = 1	-0.041 (0.046)
HH head – No education, illiterate (y/n) = 1	-0.009 (0.017)
Number of permanent HH members	0.008 (0.008)
HH dependency ratio	0.005 (0.028)
Any female HH member belongs to a community-based group (y/n) = 1	-0.036* (0.021)
HH owns agricultural land (y/n) = 1	-0.036** (0.017)
Size of agricultural land (in decimals)	0.001 (0.001)
Wealth index	-0.008 (0.005)
Treatment # HH head – Age (in years)	-0.000 (0.001)
Treatment # HH head – Married (y/n) = 1	0.018 (0.086)
Treatment # HH head – Gender (Male = 1) = 1	0.055 (0.068)
Treatment # HH head – No education, illiterate (y/n) = 1	0.036 (0.023)
Treatment # Number of permanent HH members	-0.009 (0.010)
Treatment # HH dependency ratio	0.014 (0.034)
Treatment # Any female HH member belongs to a community-based group (y/n) = 1	-0.008 (0.027)
Treatment # HH owns agricultural land (y/n) = 1	0.027 (0.025)
Treatment # Size of agricultural land (in decimals)	-0.001* (0.001)
Treatment # Wealth index	-0.007

	Respondent attritted between baseline and endline survey
	(0.008)
Dacope	0.002 (0.021)
Koyra	-0.053** (0.022)
Paikgachha	-0.004 (0.020)
Shyamnagar	-0.013 (0.033)
Number of observations	3,050
F-test of joint significance (p-value)	0.207

Source: Authors.
Note: SEs are adjusted for clustering at the UP level and stratification on *upazila*. Column (1) significance stars: ** p < 0.05, and * p < 0.10.

Table A - 7. Regression of attrition dummy variable on treatment status, relevant baseline outcomes and their interaction

	Respondent attritted between baseline and endline survey
Treatment	0.111 (0.080)
Total income last month, p.c.	-0.000 (0.000)
Total income, p.c.	-0.000 (0.000)
Income diversification	-0.016 (0.011)
FCS [0-112]	-0.001* (0.000)
HDDS one-day recall [0-10]	0.009 (0.006)
Mildly Food Insecure Access	0.018 (0.016)
Moderately Food Insecure Access	0.043* (0.026)
Severely Food Insecure Access	0.048** (0.019)
Non-food expenditure, p.c.	-0.000 (0.000)
Food expenditure, p.c.	-0.000 (0.000)
Beneficiary engages in at least one IGA=1	0.012 (0.018)
Treatment # Total income last month, p.c.	0.000 (0.000)

	Respondent attritted between baseline and endline survey
Treatment # Total income, p.c.	-0.000 (0.000)
Treatment # Income diversification	-0.003 (0.014)
Treatment # FCS [0-112]	0.001 (0.001)
Treatment # HDDS one-day recall [0-10]	-0.014 (0.009)
Treatment # Mildly Food Insecure Access	-0.022 (0.026)
Treatment # Moderately Food Insecure Access	-0.066* (0.035)
Treatment # Severely Food Insecure Access	-0.113*** (0.040)
Treatment # Non-food expenditure, p.c.	0.000 (0.000)
Treatment # Food expenditure, p.c.	0.000 (0.000)
Treatment # Beneficiary engages in at least one IGA=1	-0.020 (0.031)
Dacope	-0.033 (0.023)
Koyra	-0.061** (0.023)
Paikgachha	-0.001 (0.025)
Shyamnagar	-0.019 (0.034)
Number of observations	3,090
F-test of joint significance (p-value)	0.041

Source: Authors.
Note: HDDS = Household Dietary Diversity Score. SEs are adjusted for clustering at the UP level and stratification on *upazila*. Column (1) significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

Outcomes

Table A - 8. Description of each outcome variable

OUTCOME FAMILY	OUTCOME VARIABLES
Household welfare	Total income, p.c.; Total income last month, p.c.; Total expenditure, p.c.
Food security	FCS [0-112]; Acceptable high FCS (>52); HFIAS [0-27]; Food secure (y/n); Mildly food insecure access (y/n); Moderately food insecure access (y/n); Severely food insecure access (y/n)
Shock preparedness	Self-reported preparedness against extreme weather events; Income diversification
Women empowerment – Income generation	Beneficiary engages in at least one IGA; Beneficiary – # of IGA engaged in; # of IGA – Women in HH solely responsible; Beneficiary – Share of IGA engaged in alone/with other women in HH; Women in HH solely responsible for at least one adaptive LH; # of adaptive LH women in HH solely responsible for
Women empowerment – Decision-making	Beneficiary solely decides on income from crop production; Beneficiary solely decides on income from fish/prawn/crab production; Beneficiary solely decides on income from livestock production; Beneficiary solely decides on income from agricultural wage employment; Beneficiary solely decides on income from non-agricultural wage employment; Beneficiary solely decides on income from HH non-farm enterprise; Beneficiary sole decision maker for income from at least one source; Decision-making involvement index [1-5]
Household expenditures	Food expenditure, p.c.; Non-food expenditure, p.c.; Education expenditure, p.c.; Clothing expenditure, p.c.; Health expenditure, p.c.; Communication expenditure, p.c.; Social Events expenditure, p.c.; Refreshments expenditure, p.c.; Miscellaneous expenditure, p.c.

Source: Authors.

Robustness checks

Table A - 9. Sensitivity of ITT estimates to attrition

	ITT x NEWCOMERS	(SE)	NO. OF OBSERVATIONS
Household welfare			
Total income, p.c.	4,325	(4,619)	3,099
Total income last month, p.c.	993	(678)	3,099
Total expenditure, p.c.	1,306	(3,214)	3,099
Household food security			
FCS [0-112]	3.2	(2.6)	3,104
Acceptable high FCS (>52)	0.116	(0.082)	3,104
HDDS one-day recall [0-10]	-0.003	(0.236)	3,104
High HDDS (7 or more food groups)	-0.001	(0.069)	3,104
HFIAS [0-27]	-0.18	(0.23)	3,104
Food secure (y/n)	0.087	(0.068)	3,104
Mildly food insecure access (y/n)	-0.093	(0.059)	3,104
Moderately food insecure access (y/n)	-0.002	(0.025)	3,104
Severely food insecure access (y/n)	0.005	(0.003)	3,104
Household preparedness to shocks			
HH is (somewhat) prepared against extreme weather events (self-perception)	-0.035	(0.038)	3,095
Income diversification	0.30	(0.18)	3,104
Women empowerment – decision-making			
Beneficiary solely decides on income from crop production	-0.043	(0.077)	960
Beneficiary solely decides on income from fish/prawn/crab production	0.108	(0.070)	471
Beneficiary solely decides on income from livestock production	-0.109	(0.066)	1,631
Beneficiary solely decides on income from agricultural wage employment	-0.038	(0.079)	416
Beneficiary solely decides on income from non-agricultural wage employment	-0.346**	(0.109)	418
Beneficiary solely decides on income from HH non-farm enterprise	0.154	(0.097)	292
Beneficiary sole decision maker for income from at least one source	-0.064	(0.059)	2,234
Decision-making involvement index [1-5]	-0.17	(0.15)	2,233
Women empowerment – income generation			
Beneficiary engages in at least one IGA	-0.012	(0.080)	3,088
Beneficiary – # of IGA engaged in	0.077	(0.179)	3,088

	ITT X NEWCOMERS	(SE)	NO. OF OBSERVATIONS
Beneficiary – Share of IGA engaged in alone/with other women in HH	-0.006	(0.041)	2,080
# of IGA – Women in HH solely responsible	-0.005	(0.064)	2,694
Women in HH solely responsible for at least one adaptive LH	0.059	(0.060)	3,104
# of adaptive LH women in HH solely responsible for	0.090	(0.081)	3,104
Household expenditures			
Food expenditure, p.c.	1,307	(1,745)	3,099
Non-food expenditure, p.c.	246	(2,081)	3,099
Education expenditure, p.c.	440	(240)	3,099
Clothing expenditure, p.c.	373	(175)	3,099
Health expenditure, p.c.	-40	(533)	3,099
Communication expenditure, p.c.	199	(163)	3,099
Social Events expenditure, p.c.	-20	(264)	3,099
Refreshments expenditure, p.c.	68	(168)	3,099
Miscellaneous expenditure, p.c.	-706	(1,262)	3,099

Source: Survey data and authors' computations.
Note: ITT estimates for "newcomers" (i.e. households interviewed at endline only) from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. This dummy variable is interacted with the treatment assignment variable. The table reports the coefficient estimate on this interaction term. SEs are clustered at the UP level and reported in parentheses. Significance stars are based on "sharpened" q-values to control the false discovery rate following the method of Benjamini, Krieger and Yekutieli (2006) as presented in Anderson (2008). Note that q-values are interpreted the same way as p-values. Significance stars: ** $p < 0.05$.

Table A - 10. Sensitivity of ITT estimates to outliers

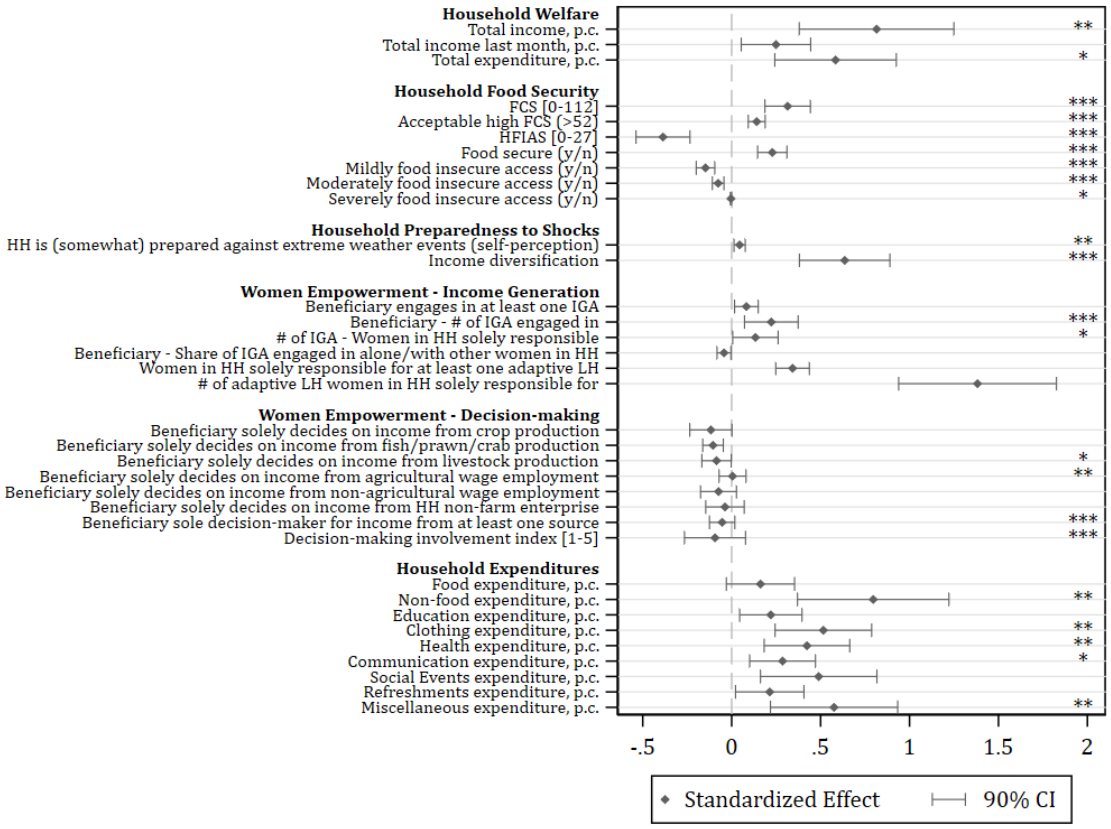
	(1) 0.5% TRIMMED	(2) 1% TRIMMED	(3) 2% TRIMMED	(4) 5% TRIMMED
Household welfare				
Total income, p.c.	14,020***	13,410**	12,059**	9,150**
Total income last month, p.c.	736**	660**	609**	448**
Total expenditure, p.c.	8,463***	7,981**	6,885**	4,796**
Household food security				
FCS [0-112]	4.6***	4.5***	4.5***	4.3***
Acceptable high FCS (>52)	0.141***	0.137***	0.139***	0.138***
HDDS one-day recall [0-10]	0.293***	0.287***	0.287***	0.284***
High HDDS (7 or more food groups)	0.065**	0.064**	0.063**	0.064**
HFIAS [0-27]	-0.65***	-0.62***	-0.58***	-0.48***
Food secure (y/n)	0.228***	0.227***	0.222***	0.209***

	(1) 0.5% TRIMMED	(2) 1% TRIMMED	(3) 2% TRIMMED	(4) 5% TRIMMED
Mildly food insecure access (y/n)	-0.147***	-0.148***	-0.149***	-0.150***
Moderately food insecure access (y/n)	-0.076***	-0.075***	-0.070***	-0.059***
Severely food insecure access (y/n)	-0.004**	-0.002**	-0.002*	0.000
Household preparedness to shocks				
HH is (somewhat) prepared against extreme weather events (self-perception)	0.045**	0.043**	0.041**	0.041**
Income diversification	0.59***	0.58***	0.58***	0.54***
Women empowerment – decision-making				
Beneficiary solely decides on income from crop production	-0.117	-0.116	-0.116	-0.118
Beneficiary solely decides on income from fish/prawn/crab production	-0.105**	-0.104**	-0.097*	-0.099*
Beneficiary solely decides on income from livestock production	-0.085	-0.085	-0.085	-0.090
Beneficiary solely decides on income from agricultural wage employment	0.005	0.003	0.001	-0.004
Beneficiary solely decides on income from non-agricultural wage employment	-0.074	-0.075	-0.071	-0.087
Beneficiary solely decides on income from HH non-farm enterprise	-0.038	-0.045	-0.043	-0.067
Beneficiary sole decision maker for income from at least one source	-0.053	-0.053	-0.053	-0.060
Decision-making involvement index [1-5]	-0.12	-0.12	-0.11	-0.12
Women empowerment – income generation				
Beneficiary engages in at least one IGA	0.083**	0.082**	0.081**	0.083**
Beneficiary – # of IGA engaged in	0.257**	0.255**	0.243**	0.253**
# of IGA – Women in HH solely responsible	0.139**	0.138**	0.129*	0.140**
Beneficiary – Share of IGA engaged in alone/with other women in HH	-0.043**	-0.043**	-0.043**	-0.042**
Women in HH solely responsible for at least one adaptive LH	0.342***	0.342***	0.342***	0.348***
# of adaptive LH women in HH solely responsible for	0.510***	0.508***	0.510***	0.518***
Household expenditures				
Food expenditure, p.c.	1,460*	1,448*	1,253*	979
Non-food expenditure, p.c.	6,727**	6,256**	5,371**	3,602**
Education expenditure, p.c.	426**	360**	313**	231
Clothing expenditure, p.c.	425**	383**	346**	273**
Health expenditure, p.c.	1,329**	1,258**	1,107**	794**

	(1) 0.5% TRIMMED	(2) 1% TRIMMED	(3) 2% TRIMMED	(4) 5% TRIMMED
Communication expenditure, p.c.	322**	292**	272**	203**
Social Events expenditure, p.c.	821**	743**	590**	391*
Refreshments expenditure, p.c.	223**	198**	163*	114
Miscellaneous expenditure, p.c.	3,112**	2,958**	2,519**	1,552**

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions after trimming 0.5 per cent (main analysis), 1 per cent, 2 per cent or 5 per cent of observations. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Significance stars are based on sharpened q-values. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

Figure A - 2. Programme impacts, at a glance – randomization inference



Source: Authors.
Note: ITT estimates for all outcome variables, with statistical significance based on randomization inference. Each row shows the OLS point estimate and 90 per cent confidence interval. For continuous variables, the effect is in expressed in (control group) SD units. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

Table A - 11. ITT estimates – randomization inference

	ITT	(SE)	Control mean	Control SD	No. of observations
Household welfare					
Total income, p.c.	14,020**	(4,437)	32,793	17,208	3,099
Total income last month, p.c.	736	(342)	2,823	2,956	3,099
Total expenditure, p.c.	8,463*	(2,936)	29,321	14,485	3,099
Household food security					
FCS [0-112]	4.6***	(1.1)	54.3	14.5	3,104
Acceptable high FCS (>52)	0.141***	(0.028)	0.527	0.500	3,104
HFIAS [0-27]	-0.65***	(0.15)	0.88	1.67	3,104
Food secure (y/n)	0.228***	(0.049)	0.690	0.463	3,104
Mildly food insecure access (y/n)	-0.147***	(0.031)	0.208	0.406	3,104
Moderately food insecure access (y/n)	-0.076***	(0.019)	0.096	0.294	3,104
Severely food insecure access (y/n)	-0.004*	(0.002)	0.006	0.079	3,104
Household preparedness to shocks					
HH is (somewhat) prepared against extreme weather events (self-perception)	0.045**	(0.019)	0.909	0.288	3,095
Income diversification	0.59***	(0.14)	2.17	0.92	3,104
Women empowerment – income generation					
Beneficiary engages in at least one IGA	0.083	(0.039)	0.687	0.464	3,088
Beneficiary – # of IGA engaged in	0.257***	(0.103)	1.235	1.154	3,088
# of IGA – Women in HH are solely responsible	0.139*	(0.079)	1.008	1.042	3,088
Beneficiary – Share of IGA engaged in alone/with other women in HH	-0.043	(0.023)	0.830	0.316	2,234
Women in HH solely responsible for at least one adaptive LH	0.342	(0.056)	0.101	0.302	3,104
# of adaptive LH women in HH solely responsible for	0.510	(0.097)	0.113	0.369	3,104
Women empowerment – decision-making					
Beneficiary solely decides on income from crop production	-0.117	(0.070)	0.301	0.460	960
Beneficiary solely decides on income from fish/prawn/crab production	-0.105	(0.034)	0.176	0.382	471
Beneficiary solely decides on income from livestock production	-0.085*	(0.049)	0.307	0.462	1,631
Beneficiary solely decides on income from agricultural wage employment	0.005**	(0.045)	0.269	0.445	416
Beneficiary solely decides on income from non-agricultural wage employment	-0.074	(0.060)	0.341	0.475	418

	ITT	(SE)	Control mean	Control SD	No. of observations
Beneficiary solely decides on income from HH non-farm enterprise	-0.038	(0.064)	0.284	0.453	292
Beneficiary sole decision maker for income from at least one source	-0.053***	(0.042)	0.329	0.470	2,234
Decision-making involvement index [1-5]	-0.12***	(0.13)	3.48	1.24	2,233
Household expenditures					
Food expenditure, p.c.	1,460	(1,026)	19,179	9,022	3,099
Non-food expenditure, p.c.	6,727**	(2,135)	10,138	8,453	3,099
Education expenditure, p.c.	426	(201)	1,405	1,936	3,099
Clothing expenditure, p.c.	425**	(133)	1,478	824	3,099
Health expenditure, p.c.	1,329**	(448)	2,255	3,140	3,099
Communication expenditure, p.c.	322*	(124)	981	1,126	3,099
Social events expenditure, p.c.	821	(326)	634	1,677	3,099
Refreshments expenditure, p.c.	223	(119)	930	1,041	3,099
Miscellaneous expenditure, p.c.	3,112**	(1,147)	2,455	5,404	3,099

Source: Survey data and authors' computations.
Note: ITT estimates from OLS regressions. Regressions include randomization strata (*upazila*) dummy variables and baseline outcome values, when available. For cases where the baseline outcome value is missing, the latter is replaced by 0 and the regression is augmented by a companion dummy variable equal to 1 if the baseline outcome value is missing, and 0 otherwise. SEs are clustered at the UP level and reported in parentheses. Statistical significance based on randomization inference. Significance stars: *** p < 0.01, ** p < 0.05, and * p < 0.10.

Table A - 12. Selected livelihood option 1 (total endline sample, October 2023)

	Frequency	Percent	Cumulative frequency
Aqua geoponics	904	28.97	28.97
Crab and fish feed processing	12	0.38	29.36
Crab farming	271	8.69	38.04
Crab nursery	17	0.54	38.59
Homestead gardening	922	29.55	68.14
Hydroponics	494	15.83	83.97
Plant nursery	57	1.83	85.80
Sesame cultivation	442	14.20	100.00
Total	**3,120**	**100.00**	

Source: Authors.

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Independent Evaluation Unit
Green Climate Fund
175, Art center-daero. Yeonsu-gu
Incheon 22004
Republic of Korea
Tel. (+82) 032-458-6450
ieu@gcfund.org
https://ieu.greenclimate.fund