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A process evaluation of a home garden intervention

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Abstract

Background Most reviews of nutrition-sensitive programs assess the evidence base for nutrition outcomes without considering how programs were delivered. Process evaluations can fill this void by exploring how or why impacts were or were not achieved. This mid-term process evaluation examines a home garden intervention implemented in a large-scale, livelihoods improvement program in Odisha, India. The objectives are to understand whether the intervention was operating as planned (fidelity), investigate potential pathways to achieve greater impact, and provide insights to help design future home garden programs.

Methodology Data collection and analysis for this theory-driven process evaluation are based on a program impact pathway that shows the flow of inputs, processes, outputs, outcomes, and impacts. Quantitative and qualitative data from focus group discussions, semi-structured interviews, and a Process Net-Mapping exercise with beneficiaries, frontline workers, and program management staff.

Results Despite a mismatch between the design and implementation (low fidelity), the process evaluation identified positive outputs, outcomes, and impacts on home garden production, consumption, income, health and nutritional outcomes, and women's empowerment. Flexibility led to greater positive outcomes on nutrition, the adoption of sustainable agricultural practices and easy-to-understand nutrition models, and the likelihood of the intervention being sustained after the program ends.

Conclusions To help food systems in rural settings reduce food insecurity by utilizing more sustainable agricultural practices, we recommend that home garden interventions include instruction on easy-to-understand nutrition models and on how to make natural fertilizer. Finding local solutions like home gardens to help address critical supply issues and food insecurity is paramount.

Keywords Process evaluation, Home garden, Food security, Sustainable agriculture, Program impact pathway, Process net-mapping, India

Introduction

There is an urgent need to implement local solutions that enable households to increase their food and nutrition security, especially in developing economies [36], while helping contribute to more sustainable food systems. Home gardens, also called kitchen, backyard, farmyard, compound, or homestead gardens [18], refer to a small area of cultivated land located around or close to the household [16] that are often managed by women [65] and can raise vegetables, fruits, spices, herbs, ornamental and medicinal plants, staples, and livestock [18].

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They can be a form of nutrition in both rural and urban areas [47]. The International Fund for Agricultural Development (IFAD) writes that integrated home gardens are “one of the most promising pro-poor strategies to address undernutrition and specific nutritional deficits such as micronutrient deficiencies” ([26]: p. 1). Because home gardens are an increasingly important strategy to address local food insecurity and IFAD incorporates homestead food production into its nutrition-sensitive projects, it is important to examine how they work, whether they improve food security, and how they may contribute to more sustainable food systems.

Previous studies have recognized that home gardens can play a vital role in improving household food and nutritional security, diversifying food systems, and human diets [6, 33, 45], providing an additional source of income and livelihood opportunities for resource-poor households [17, 18, 36, 40, 64], improving women’s empowerment [54], and accruing environmental benefits [18]. While impact evaluations focus on identifying the impact of interventions, they offer limited insight into how or why impacts were achieved or not achieved, such as by focusing on impact indicators from baseline and midline data without examining the means to an end [21, 61]. For example, randomized control trials are often referred to as the gold standard [74] and may yield significant results, yet they may face deviation from intended interventions [8] and lack information that is critical for program development that a process evaluation could answer, such as how an intervention could be replicated and whether outcomes can be repeated in specific contexts [21, 22, 48]. Process evaluations can pry open the “black box” of interventions by providing a more complete picture of program performance [19, 61]. The goal of a process evaluation is to identify discrepancies between the program as intended and the program as implemented [8], which is called fidelity [63, 72], as well as to understand how programs operate and provide recommendations for improvement [19]. Undertaking a process evaluation is critical to understanding reasons behind a program’s implementation effectiveness or failures [22]. Through a program impact pathway (PIP), a process evaluation traces inputs, processes, outputs, outcomes, and impacts of an intervention [35]. In a retrospective review of the Alive & Thrive’s approach of combining impact and process evaluations, ([39]: 2) write, “Our strategy to studying pathways to impact and context was *central* to the learning.”

This study is a process evaluation of a large-scale, nutrition-sensitive program called the Odisha Particularly Vulnerable Tribal Groups (PVTGs) Empowerment and Livelihoods Improvement Program (OPELIP). Through over three dozen interventions—one of which

is the home garden intervention—OPELIP aims to improve the livelihoods of 62,356 PVTG and surrounding tribal and non-tribal households in 1125 villages located in 17 administrative areas called Micro Project Areas (MPAs) in the state of Odisha, India from 2017 to 2024 [24]. The program was implemented in MPAs with PVTGs. Therefore, there was no control group in the project given that program placement was non-random [31]. The concept for a home garden intervention in OPELIP stemmed from PVTGs’ suffering from food insecurity [24, 55], cultivation being limited to growing crops for cash rather than for home consumption, and tribal and rural communities lacking knowledge of the nutritional value and consumption of foods that can be easily cultivated [52]. The intervention had the goal of improving vegetable and fruit production, women’s empowerment, livelihoods, and food and nutrition security [28]. The objectives of this process evaluation are to explore whether the intervention was operating as planned (fidelity), investigate potential pathways to achieve greater impact in the program’s second half, and provide recommendations to help design future home garden interventions.

This study provides several contributions to literature. First, in addition to little attention paid to nutrition-sensitive agriculture in the literature [5], most reviews of nutrition-sensitive programs thus far have assessed the evidence base for nutrition outcomes without consideration of how successful programs were delivered [22, 46, 50]. Second, there are very few process evaluations of home garden interventions [49, 60]. Third, to the best of our knowledge, this study will be the first to apply the participatory Process Net-Mapping technique to examine a home garden intervention. Only a few studies have applied this method to large-scale nutrition programs [3, 10]. Process Net-Mapping provides additional insights over other research techniques by identifying and discussing the roles and influence different actors play in a program, policy, or food system [34], as well as identifying challenges and bottlenecks [1]. The results from this process evaluation will assist future home garden interventions and nutrition-sensitive programs by providing insights into how their design and implementation could be improved to achieve greater impact and to lead to more sustainable food systems.

The remainder of this paper is organized as follows. Sect. “[Methodology](#)” explains the mixed-method methodology. Sect. “[Results](#)” contains the results, which are divided according to the steps in the PIP, namely inputs, processes, outputs, outcomes, and impacts. Sect. “[Discussion](#)” discusses the results in terms of whether the program achieved fidelity and how this affected the program’s outcomes and impacts before providing

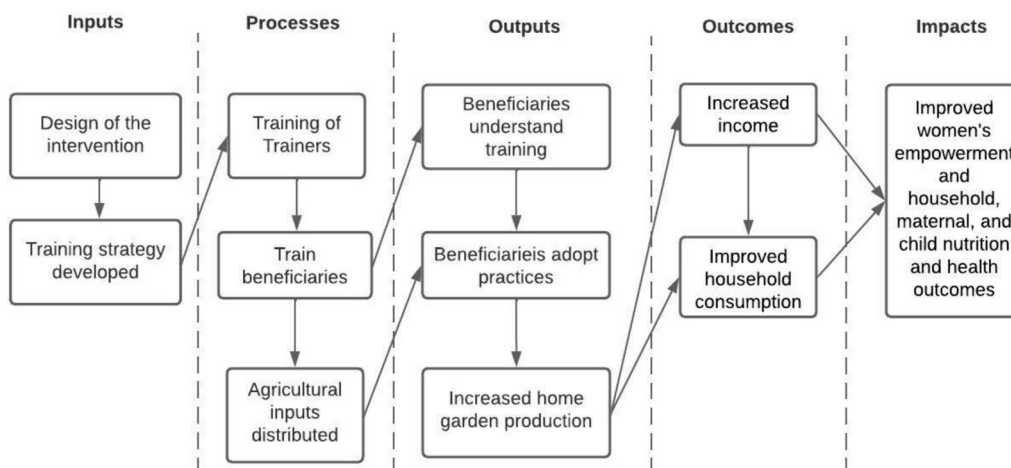


Fig. 1 Program impact pathway for the home garden intervention Source: Authors' illustration

recommendations. Sect. "Conclusions" provides concluding remarks.

Methodology

This process evaluation is theory driven and relies on mixed methods combining quantitative and qualitative data, as well as an extensive document review. Our methodological approach is based on the following four key principles of a process evaluation ([61]: S212):

1. Developing detailed PIP models;
2. Linking data collection to PIPs and using mixed methods and multiple data sources;
3. Linking evaluation activities within program implementation timelines; and
4. Engaging with program implementation and management teams.

Below, we discuss how we applied these four principles.

Through the aid of PIPs, process evaluations identify how impacts emerge from program inputs, processes, outputs, and outcomes [31] to shed light on barriers and facilitators of participation and uptake. PIPs are a tool that: conceptualize flows and identify inefficiencies, assist program planning, management, evaluation; guide the design of survey instruments; and shed light on the generalizability of implementing similar programs [22]. The PIP model has been used in other theory-driven process evaluations to track implementation and behavior [38, 61]. The PIP for the home garden intervention is shown in Fig. 1. Inputs include the design of the intervention and training strategy, as well as financial, technical, and managerial inputs. These inputs lead to processes, which are conducting training and distributing agricultural inputs. Outputs include beneficiaries understanding the training

and adopting the recommended practices, which lead to increased production from home gardens. Outcomes include the concepts of production leading to improved consumption of fruits and vegetables as a direct result of home garden production (the production–consumption pathway), as well as the concept of production leading to increased income (the production–income pathway) which would increase household’s purchasing power. Impacts are improved women’s empowerment and nutrition and health outcomes. The outcomes and impacts explored in this process evaluation are qualitative.

As the second principle suggests, we used a mixed methods approach and multiple data sources, which has also been adopted in other process evaluations (i.e., [60, 66]). As shown in Table 1, we relied on three primary data collection techniques: Process Net-Mapping, semi-structured interviews, and focus group discussions. Process

Table 1 Data collection methods

Method	Respondents/source
Process net-mapping	1 exercise with program management unit staff
Semi-structured interviews	3 with program management unit staff 11 with micro project area-level staff 57 with frontline workers
Focus group discussions	1 with program management unit staff 7 with beneficiaries
Document review	Design completion report [24] President’s report [27] Implementation and guideline reports [30, 52] Supervision and monitoring and evaluation reports [25, 29, 68, 69] Impact assessment plan [31] Baseline report [32] Internal materials

Net-Mapping is an underutilized participatory method developed by Birner et al. [11] that is a modification of the Net-Map method [67]. The Process Net-Mapping technique was developed to analyze challenges arising from the implementation of public or donor-funded programs and is recommended to address problems of high complexity [43]. By mapping out consecutive steps of a program's implementation process, identifying actors involved and their influence levels, Process Net-Mapping provides additional insights over other research methods by shedding light on how an activity was implemented, the flows of inputs and resources, power dynamics (called influence levels), and bottlenecks. We undertook a Process Net-Mapping exercise with Program Management Unit (PMU) staff based on who had extensive knowledge and experience with home gardens.

Semi-structured interviews were conducted with PMU-, MPA-, and village-level staff and focus group discussions were conducted with PMU-level staff and beneficiaries.

To select the MPAs where the MPA- and village-level interviews were held, PMU-level staff were asked to provide three MPAs that had successful implementation of the home garden intervention (Lanjigarh, Chatikona, and Keonjhar) and three that had less successful implementation (Sunabeda, Belghar, and Jamardih). The semi-structured interviews and focus group discussion at the MPA and village-level were spread across these six MPAs to gather data from MPAs with varying levels of success. Purposeful sampling was utilized in selecting respondents to ensure the respondents had knowledge and experience about the home garden intervention (Crews et al. and Poth, 2005) and to gather perspectives from different types of respondents in terms of age, gender, and socioeconomic status. Accordingly, qualitative principles of completeness (a broad spectrum of actors) and dissimilarity (diverse perspectives) were applied [9] to try to ensure a representative sample [2]. Focus group discussions were selected to elicit in-depth responses from beneficiaries, as well as to understand and reveal beliefs, opinions, and nuanced effects of the program on beneficiaries and their families [51].

Focus group discussions have been utilized for decades and serve as a bridge between scientific research and local knowledge (i.e., [15]). However, focus group discussions can suffer from bias, such as social desirability bias [7]. Several strategies were adopted to help overcome the possibility of bias in the focus group discussions, such as utilizing a facilitator with a particular skillset, someone with active listening skills and a warm, caring rapport [37]. Our aim was to reduce bias through triangulation using a wide range of respondents and different data sources [71].

Focus group discussions and semi-structured interviews were audio recorded with participant consent and later transcribed. Multiple-choice questions from the semi-structured interviews were tabulated in Excel by the lead of the enumerator and transcription team who is fluent in both the local language (Odia) and English. These data were analyzed in Excel to calculate averages and the share of respondents who answered multiple choice questions. Respondents who did not answer a particular question were excluded from the analysis for that question. A researcher read the transcripts to confirm that data entered in Excel from the transcripts were valid. The method of narrative analysis (e.g., [41, 44, 62]) was used to examine the transcripts. Major themes and quotes were extracted from each transcript by two researchers. The reporting of results focuses on these major themes and supporting quotes. Data were analyzed in the context of the PIP from inputs to impact. In this report, to ensure anonymity, PMU- and MPA-level staff are not identified by their job title.

Regarding the last two principles, this process evaluation was purposefully conducted halfway through OPELIP's implementation, so that findings and insights can be used to improve the program's second half. The process evaluation team engaged with PMU-level staff throughout the study. The Process Net-Mapping exercise, one semi-structured interview, and a focus group discussion with PMU-level staff were conducted a month before beneficiaries and frontline workers were interviewed. After preliminary results were available, a member of the process evaluation team visited program areas to witness implementation first-hand and to follow-up with frontline workers. In addition, preliminary results were presented to PMU-level staff and follow-up semi-structured interviews were conducted with PMU-level staff both in-person and remotely. The process evaluation team thus engaged with program implementation and management teams before, during, and after data collection and analysis. This was done to ensure the validity of the results and to engage with program staff to increase the likelihood of their support of the process evaluation and of the likelihood of their adopting the process evaluation team's recommendations.

Results

The results are presented in terms of the five components of the PIP—inputs, processes, outputs, outcomes, and impacts (see Fig. 1). To understand the structure of the program and actors involved, we first provide an overview of the actors involved (see Fig. 2). Starting at the top of the organizational structure, the PMU is at the state-level and is responsible for day-to-day program management. The MPA-level is responsible for implementation



Fig. 2 Actors involved in the home garden intervention Source: semi-structured interviews and the design completion report [24]

and each of the 17 MPAs includes a Micro Project Agency and a facilitating non-governmental organization. At the village-level, a Village Development Committee composed of villagers decides which interventions to implement through a five-year Village Development Plan that is approved by the Micro Project Agency. Village Development Committees identify potential beneficiaries with the help of MPA-level and village-level staff. Community Resource Persons are responsible for ensuring program implementation in two to three villages each and are from the same communities where they work.

Inputs

The first step in the PIP focuses on the design of the intervention, which is necessary to examine fidelity. The home garden intervention was designed by IFAD and national-level experts. The Design Completion Report [24] has the goal that 32,000 PVTG households with 40 to 400 square meters of land be provided home garden support by the end of the program. Beneficiaries are supposed to receive a package consisting of a water storage tank, drum-based drip system, hose, trellises, fences, vegetable seeds, planting materials, technical information on land preparation, seed sowing, water management mulching, pest control, and seed selection and preservation [24, 57]. Model or

demonstration home gardens located next to Nutrition Resource Centers are supposed to be established by Community Service Providers and maintained by self-help groups to train beneficiaries [52, 58]. There were no further requirements for beneficiaries or recommendations on whom to prioritize. The design encouraged that nutrition education on basic health and nutritional topics be provided through production interventions, but did not specify which of the over three dozen interventions that are part of OPELIP are considered production interventions. Lastly, the Design Completion Report had no information on how frontline workers or beneficiaries were to be trained.

Based on the expertise of the PMU and experiences during the first few years of program implementation, the home garden intervention underwent several changes since implementation began in 2018. Because of budgetary constraints and the lack of guidance in the program's design on targeting beneficiaries, the PMU decided that the home garden intervention should first focus on the poorest households, households without agricultural land, households with land next to their homestead, and households who already had papaya or drumstick trees. In 2021, the PMU rolled out a new iteration that promotes fruits, such as banana, tuber crops, mango, guava, coconut, lemon, and tamarind. The reason for this change was to make home gardens more sustainable since the original design focused on vegetables that had only one growing season. In 2022, as part of a pilot intervention in OPELIP, some self-help groups established home gardens to supply nutritious meals to young children at daycares. Although not widespread—only two such daycare centers were operational in 2022—this was nonetheless a positive addition to the program as it supplied important micronutrients to vulnerable children and planted the seed early on in terms of the importance of local, sustainable solutions to food insecurity.

Nutrition education is incorporated into the home garden intervention by providing basic information on the importance of home gardens for a diverse diet and micronutrients. The new iteration also incorporates nutrition education through two easy-to-understand models: the 7-din 7-ghar and Tirangi Thali models. These models are from an IFAD project in Madhya Pradesh that led to improved food intake and dietary diversity [14]. In the 7-Din 7-Ghar model, households are encouraged to grow seven types of vegetables in seven different vegetable beds close to their homes. Households are supposed to pick one type of vegetable each day, so that all seven vegetable beds are picked and eaten during a week. The Tiranga Thali model is a simple message that households should prepare meals that include the three colors of the Indian flag (white, green, and saffron).

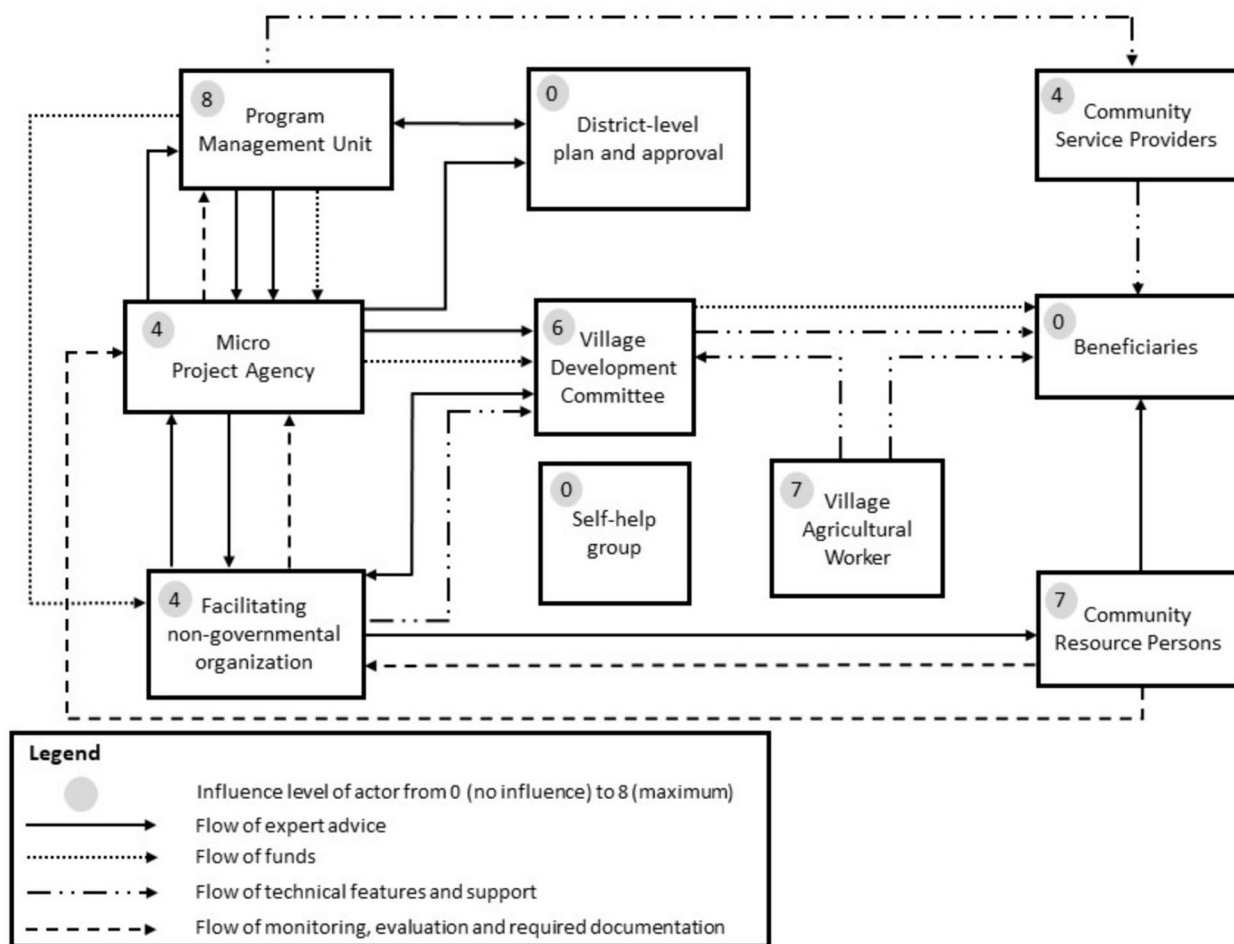


Fig. 3 Actors involved in the home garden intervention and their influence levels Source: Digitalized version of the map created during the process net-mapping exercise

Based on this updated design of the home garden intervention that included both fruit and vegetables, a Process Net-Mapping exercise in November 2021 examined the flows of information, funds, technical support, and monitoring and evaluation, as well as the level of influence of actors in the home garden intervention. A digitalized version of the map is shown in Fig. 3. A total of 11 types of actors were discussed. Influence levels vary from zero (no influence) to eight (the highest level of influence). The PMU-level participants assigned themselves the highest level of influence. This may be because the exercise focused on the flow of funds, technical advice, and documentation. At the MPA-level, Micro Project Agencies and facilitating non-governmental organizations were assigned an influence level of four. Self-help groups were assigned a level of no influence and are not connected to any other actor on the map despite the important role they were supposed to play. Given the importance of the Design Completion Report placed on beneficiaries, it was

unexpected that beneficiaries were assigned a level of no influence. Beneficiaries were supposed to be actively involved in OPELIP, such as by participating in Village Development Committees. Perhaps their influence was reflected in the high level of influence (six) assigned to Village Development Committees, which are formed from beneficiaries. Also, at the village-level, Village Agricultural Workers and Community Resource Persons were assigned high influence levels. The map visualizes the flow of funds from the PMU, to the MPA-, to the village-level, as well as the flow of monitoring, evaluation, and documentation in the reverse direction. The flow of information and technical features and support go in both directions. Documentation and monitoring and evaluation information flows from the bottom up based on data collected by frontline workers requested by the Project Management Unit.

The above results on the first step in the PIP show that the original design of the home garden intervention

Table 2 Frontline worker training and service delivery

	Frontline workers (N = 57 %)
<i>Health and nutrition topics frontline workers received training on</i>	
Infant and young child feeding practices (N = 46)	95.7
Water, sanitation, and hygiene (N = 52)	98.1
Tiranga Thali model (N = 53)	47.2
7-din 7-ghar model (N = 54)	51.9
<i>Quality of training</i>	
Average length of training (N = 48)	13.5 h
Received refresher training (N = 44)	68.2
<i>Quality of service delivery to beneficiaries</i>	
Did not receive any funds for training (N = 53)	60.4
Did not receive any materials for training (N = 49)	49.0
Received a poster (N = 49)	10.2
Received a video (N = 49)	16.3
Received pictures or the Mother and Child Protection Cards (N = 49)	8.2
Received a handbook (N = 49)	22.5
Submitted documentation (N = 52)	98.1
Average number of beneficiaries (N = 40)	140.3
Repeat contact with beneficiaries (N = 49)	81.6

Frontline worker survey with 57 frontline workers

Due to incomplete responses, not all 57 respondents answered each question

differed from the version implemented by expanding to include fruits and two easy-to-understand nutrition models, as well as by targeting women and households with larger land plots. The Design Completion Report lacked information on the training strategy for both frontline workers and beneficiaries and details on the expected outcomes and impacts, which will likely affect the following steps in the PIP.

Processes

Following the inputs and design of the home garden intervention, the next step in the PIP is processes, which includes frontline workers training, beneficiary selection and training, the technical assistance and guidance to establish home gardens, and the distribution of agricultural inputs.

Training was designed by PMU-level officials and experts who consulted training manuals. Frontline workers received training about home gardens within their respective MPAs from Junior Agricultural Officers. According to the PMU, training sessions lasted two days, which corresponds to the average number of hours frontline workers reported (13.5 h). However, some frontline workers reported receiving only a few hours of training and that training was in the classroom only with no field visits. Frontline workers were trained on a variety of topics, including seed preparation, soil preparation, plant

watering, how to dig a well, how to plant a tree, fence building, seedling planting, fertilizer application, harvesting, field and seed bed preparation, seed and seedling preparation, water storage and management, and planting distances, as well as on health and nutrition topics (see Table 2). Only about half of frontline workers reported receiving training on the easy-to-understand Tiranga Thali or 7-din 7-ghar nutrition models. Most (68.2%) frontline workers reported receiving refresher trainings, which were on topics such as on how to make organic fertilizer, bio pesticide, and/or vermicompost. Frontline workers together with the Village Development Committee were responsible for identifying potential beneficiaries to participate in the home garden intervention, yet the number of targeted beneficiaries is behind schedule. According to the PMU, funding constraints have prevented the expansion of the home garden intervention from reaching more households. A setback for funding and budgeting is that because the program covers such a wide area, costs vary greatly across and within MPAs, making planning difficult. Moreover, the PMU said that they didn't have sufficient operational funds to implement the program as it was designed.

Frontline workers were responsible for passing information they received training on to beneficiaries through an initial training session and continuing to provide technical assistance and guidance on establishing and

maintaining home gardens through repeat contact with beneficiaries. Each frontline worker was responsible for an average of 140 beneficiaries. About 80% of frontline workers had repeat contact with beneficiaries, which were often one-on-one visits to beneficiary home gardens. Frontline workers took pictures of plants, discussed any challenges, and answered questions during these visits. According to frontline workers, repeat contact with beneficiaries helped improve beneficiaries' understanding of the topics. According to the PMU, demonstrations and brochures were the main methods used to train beneficiaries; however, in reality, training sessions were brief and mainly oral. For example, a beneficiary in a focus group discussion stated, "They (trainers) discussed the topics with us verbally and provided some leaflets." Some frontline workers reported training beneficiaries in the classroom only with no field visits, despite frontline workers reporting that the best place for beneficiaries to receive and understand training was through field demonstrations. There were a few notable exceptions: Community Resource Persons demonstrated seedlings on beneficiaries' plots, a few villages had model home gardens established by self-help-groups, and hands-on training was provided on how to make natural fertilizer (*Jeevamruta* and vermicompost).¹ Some frontline workers strayed from their training and adapted the home garden intervention to local conditions, such as by teaching beneficiaries how to grow vegetables in containers if the land was too steep or rocky.

It was difficult for frontline workers to reach beneficiaries due to beneficiaries' lack of time and the area's poor infrastructure. Many PVTG households travel into the forest and stay there for weeks to collect forest products to sell. Moreover, some beneficiaries, especially women, could not attend training due to their busy schedules. Beneficiaries in a focus group discussion said, "Some women are not attending the training" and "They (women) are always busy with work." Sparse mobile phone networks and poor road infrastructure made contacting beneficiaries difficult. A frontline worker explained this difficulty by saying, "As we are working mostly in the PVTG area, there is no mobile network. We must walk for 2 to 3 km to reach the destination, and so it becomes difficult to work and implement the program." Another frontline worker said, "There is no mobile network and poor road infrastructure. So, we have to visit

and inform beneficiaries about the program one day before the scheduled program." Frontline workers are not compensated for travel costs, affecting their motivation to contact beneficiaries in hard-to-reach areas.

In addition to training, frontline workers were also responsible for distributing agricultural inputs to beneficiaries. Inputs were purchased by program staff, distributed to each village, and then distributed to beneficiaries. Interviews suggest that this process worked relatively smoothly for the inputs that were procured. According to the majority (73%) of frontline workers, all inputs that were promised to beneficiaries were provided. Irrigation and fencing issues were recurrent themes throughout the interviews. According to the design, beneficiaries were supposed to receive fencing and irrigation materials as part of the package of inputs; however, beneficiaries reported not receiving these critical inputs. For example, a beneficiary said, "The few plants we have planted, the goats ate." Another beneficiary elaborated on this by saying, "(There is a) lack of fencing to protect gardens from stray animals because there is no practice of keeping animals like cattle and goats in sheds in our village. Provision of wire fencing is important to protect the garden from cattle and goats ... permanent fencing should be there because there is budget for fencing for a year." In terms of irrigation, a beneficiary said, "Due to lack of an irrigation facility, we are unable to practice the home garden." Frontline workers and PMU-level officials corroborated the need for irrigation and fencing.

Examining training, beneficiary participation, and the distribution of inputs revealed that frontline workers did not have sufficient training materials to adequately train beneficiaries. Addressing the irrigation and fencing concerns could increase the adoption and continued use of home gardens.

Outputs

Next, we examine outputs, which includes whether beneficiaries understood the training, adopted the recommended agricultural practices, and increased home garden production.

Despite the above setbacks in training, beneficiaries believed that the training was worthwhile. For example, beneficiaries were of the view that the training introduced them to modern methods of cultivation as captured in the statement, "We have learned new methods of cultivation, improved the knowledge on vegetable cultivation, the practice of fertilizer application, and modern technology to grow and consume vegetables from home gardens." Another beneficiary said, "We learned how to do potato planting and how to plant onion. Earlier, we did not know how to plant in a better way. Now, we are able to do it in a scientific way." Another said, "We did

¹ *Jeevamruta* is an organic manure and bio-pesticide made by fermenting cow dung, cow urine, jaggery (a traditional, unrefined sugar), pulses, flour, soil and water. The result is a natural source of nitrogen, potassium, phosphorus, and other micronutrients. Vermicompost can be made with a variety of ingredients, such as a combination of food waste, water, bedding materials, and earthworms. The result is a rich source of organic nitrogen, phosphorous and potassium.

not know all of these techniques—we were broadcasting the seed. In the earlier practice, we were not getting more output.” Beneficiary understanding could have been enhanced if more audio-visual techniques had been used as well as demonstrations. For example, a beneficiary said, “They showed us video and photos, which made it easy for us to understand.”

There are several factors that inhibit the adoption and continued use of home gardens. Factors that support their adoption include support from household heads and elder family members. Likewise, existing structures in the community were instrumental in facilitating adoption. For instance, a frontline worker emphasized, “Support from self-help groups facilitated the adoption of home gardens and backyard poultry among beneficiaries.” A Community Resource Person added, “It was very easy for us to implement the intervention through self-help groups.” This was surprising given that in the Process Net-Mapping exercise, self-help groups were given an influence level of zero, indicating no influence in program implementation, as well as the fact that very few model home gardens were maintained by self-help groups. Other factors were found to inhibit the adoption and continued use of home gardens, such as lack of available and suitable land, difficult terrain, lack of irrigation, and the inability to protect home gardens from animals. Nevertheless, the above results show that despite not being implemented as planned, beneficiaries and frontline workers reported positive outputs from the intervention, such as increased vegetable production and knowledge about home gardens and nutrition.

Outcomes

Outcomes examine whether household income and consumption improved. According to interviews, vegetables consumption improved among beneficiaries. For example, a frontline worker said, “Due to home garden program, they are getting sufficient vegetables for home consumption, which was difficult (before the intervention) because they are poor. Even they (beneficiaries) were not able to buy vegetables whenever they wanted. Now they are able to eat vegetables whenever they want.” Another frontline worker said, “Earlier, they had no choice because they cultivated very few items. They were restricted to a single food item, but nowadays they have so many options and they have developed their purchase capacity to procure different food items or vegetables.” We thus found evidence of impacts on consumption through the production–consumption pathway, as well as through the income–consumption pathway, which is discussed in more detail below.

Although vegetables produced from home garden intervention were generally used for home consumption,

some households sold surplus vegetables to earn income. An Agricultural Officer said, “Earlier they had no income source other than forest and small-scale land cultivation, but after initiation of the (home garden) program, we provided them various facilities in the kharif, rabi, and summer season. Paddy rice, Mandia (finger millet), cabbage, cauliflower, tomato, brinjal, onion, and turmeric training was organized for them.... Somehow, there are some improvements.” Another effect on income from home gardens is that households spent less money on purchasing vegetables since they were able to grow vegetables themselves. For example, a frontline worker said, “Before the home garden program, beneficiaries used to purchase green vegetables from the market. They used to spend 300 Rupees per week for green vegetables. But nowadays, they are harvesting green vegetables from their backyard.” A beneficiary echoed this, saying “Now we are not going much to the market to buy vegetables as we are growing vegetables in our backyard. We are getting different kinds of vegetables at our home.”

Nutrition education was incorporated into the home garden intervention by teaching beneficiaries the Tiranga Thali and 7-din 7-ghar models, which led to positive outcomes. For example, a frontline worker said, “Before the training, they sold their vegetables without giving priority to consumption, but after the training, they are used to consuming different vegetables on different days. Nowadays, they are waiting for fruits to mature fully and then harvest fruit without selling them at an earlier stage, and they are feeding their children per their requirement.” The Tiranga Thali and 7-din 7-ghar model also had positive outcomes on consumption. For example, a frontline worker said that after learning the Tiranga Thali model, “They (beneficiaries) were shocked and regretted what they had done because they have all the food items, but they never practiced as the model. They were always focused on selling vegetables rather than consumption.” Another frontline worker also indicated, “They are implementing this model in their day-to-day life. It has been two years since we started practicing this model in our village and they are adopting it well. They are eating the vegetables and if they produce some more vegetables, they sell them in the market, which improves their economic condition.”

Examining the outcomes that stemmed from the intervention’s outputs, shows that there were positive outcomes from home gardens on beneficiaries in terms of increased vegetable consumption and surplus income.

Impacts

The last step in the PIP examines impacts. Interviews with frontline workers and beneficiaries revealed improvements in households’ maternal and child health

and nutrition outcomes, as well as women's empowerment because of the home garden intervention. For example, in a focus group discussion, a beneficiary stated, "Before this program, pregnant women were eating only rice and salt. Due to this intervention, children and pregnant women are now getting leafy vegetables and other vegetables, which are very good for their health." Frontline workers also spoke of positive impacts. For example, a frontline worker said, "The intervention has improved the nutrition of mothers and children, improved health, abilities to cook more diverse foods, consumption of different vegetables and fruits, and improved nutritional growth." The intervention reduced food expenditures and allowed women to earn income by selling surplus vegetables, which was reported to increase their empowerment. For example, a frontline worker said, "Due to this program, income has increased and the decisions by women in the house has increased. Women are becoming self-sufficient." Another frontline worker said, "Women are able to spend money for children's education and own expenditure on health from the income earned from home garden." There was also an increase in the decision-making authority for women in the household due to the intervention. A frontline worker explained: "They are actively engaged in different decision-making processes and male members of the family also give respect to their decisions, especially in relation to food consumption." Therefore, we found examples of positive impacts on women's empowerment from the home garden intervention. This could have positive effects on other parts of their lives and on other women in the community, beyond home gardens.

Discussion

Below, we discuss the results to provide insights into how and why impacts were or were not achieved, as well as critical information on program implementation to help guide the design and implementation of future home garden interventions.

Comparing the design of the home garden intervention and its actual implementation uncovered low fidelity. However, "low fidelity" is not necessarily negative. There were some positive aspects stemming from low fidelity: Beneficiaries were taught how to make their own organic pesticides and fertilizers, self-help groups provided needed micronutrients from home gardens by supplementing meals to young children at a few daycares, the intervention incorporated fruit trees to be more sustainable after the program ends, and local adaptations that strayed from recommendations allowed home gardens to be adopted by beneficiaries lacking suitable land. While organic or biofertilizer have advantages over their chemical counterparts, there are challenges to their widespread

adoption as well [4]. The new development of self-help groups supplying vegetables to young children at daycares is an opportunity for model home gardens to take root in the program. In addition, it teaches children early on the importance of local solutions to sustainable food systems. Nutrition education was recently incorporated into the intervention through easy-to-understand nutrition models (7-din 7-ghar and Tiranga Thali). Given that frontline workers and beneficiaries reported that these two models were easy to understand and adopt and the synergies between home gardens and nutrition education, more effort should be placed on including health and nutrition education into home garden interventions. This recommendation is consistent with the literature. For example, Palar et al. [53] found that education-enhanced home gardens facilitate multidimensional nutrition and health improvements in vulnerable populations. However, multi-sectoral coordination of nutrition-sensitive programs is key [56].

The process evaluation identified positive outputs, outcomes, and impacts from the home garden intervention on home garden production, consumption, income, health and nutritional outcomes, and women's empowerment, suggesting an increase in food security and potential for reducing malnutrition for beneficiary households. Follow-up and repeat visits by frontline workers were key to solidifying knowledge passed during training sessions and to answer questions. Through the production–consumption pathway, beneficiaries and frontline workers reported that the home garden intervention acts to increase the supply and consumption of a diverse range of vegetables, thereby contributing to their food and nutrition security. These findings are consistent with other studies, which found that home gardens increased the production and consumption of vegetables [13, 17, 70]. Another pathway for which we found evidence is the production–income pathway. Income earned from home gardens was used for savings, educational expenses, and buying other food items. Previous studies similarly found that beneficiaries of home garden interventions generated income by selling surplus produce [6, 13, 45, 59, 60, 65] and that this income can be used to buy higher quality food and improve their nutritional status [46]. Moreover, Patalagsa et al. [54] point to the indirect effect of saving money through not having to buy food that is produced in the home garden intervention, which frees up income to buy other food items, which our results confirm. Regarding empowerment, qualitative evidence found that the home garden intervention increased decision-making authority for women within the household, providing women more opportunities to leave their homes to become more engaged in the community. Positive impacts on women's empowerment from

home gardens have been found in previous studies [46, 54]. Regarding interventions aimed to improve women's empowerment, the literature suggests that multi-component interventions, like OPELIP, are more sustainable than single-focused ones [8].

Despite the benefits of home gardens, there are challenges that impede their adoption, continued use, and sustainability. These challenges—some of which lie beyond the means of the program to overcome—include limited availability of land and water to establish a home garden, predominantly verbal and classroom training with limited on-farm demonstrations, lack of model or demonstration home gardens, difficulty reaching beneficiaries due to poor roads and mobile phone connectivity, language barriers, destruction of gardens by stray animals, and targeting one household member only. Regarding training, training tools for both frontline workers and beneficiaries should include videos, demonstrations, and site visits to model home gardens. These are likely to aid understanding and acceptability of the intervention. Setting up a model home garden in each intervention village is one way to promote the program, improve the level of understanding among beneficiaries, and spark interest in not yet involved villagers. As production depends on adequate water, improving access to water for irrigation is critical to the successful adoption of home gardens and other production-oriented activities. Access to irrigation can increase the number of annual harvests from one to three in the program area. The intervention could link up with other programs to provide dams, wells, boreholes, or other facilities that would make water more available. In villages with boreholes, fitting them with water-lifting technologies will reduce the burden of having to fetch distant water to irrigate crops in home gardens. There is a need to improve physical infrastructure, such as irrigation, roads, transportation systems, and telecommunication, increasing access to beneficiaries. Investing in such infrastructure will also better link households to markets where surplus produce from home gardens can be sold.

Social capital was found to be both an inhibitor and enabler of home gardens. In particular, some households who showed interest in the intervention did not join and some who joined later dropped out due to lack of support from their family. We recommend that future programs provide training and information on home gardens to other family members as well, which is recommended by Prost et al. [60]. In addition, involving both women and men in the household may lead to positive realizations of the production–consumption pathway and income–consumption pathway as the literature suggests that in smallholder agriculture, women contribute more to securing food and the nutrition status of the households while men focus on market participation and

income generation [73]. Another type of social capital in the form of community institutions helped facilitate the implementation of home gardens. Specifically, self-help groups at the village-level were an entry point for the program into villages. In addition, a few self-help groups adopted home gardens to supply meals provided at day-cares for young children. Nevertheless, self-help groups were not involved in helping train beneficiaries or maintaining model home gardens to the extent that the design specified, which would have facilitated the adoption of the program.

The above challenges are not unique to this home garden intervention. Including beneficiaries in the design is one way to overcome some of these challenges, such as by making the intervention more appealing to participants and sustainable in the long run.

Conclusions

Tracing the design and implementation of a home garden intervention along its PIP revealed the unique insights a process evaluation can provide about how and why impacts were—or were not—achieved. Although the intervention had low fidelity since it was not implemented as planned, this is not necessarily a disadvantage. In the case of the home garden intervention examined in this study, if the implementation of the program had rigidly stuck to the initial plan, the program would not have included nutrition education or promoted more sustainable agricultural practices, such as teaching beneficiaries how to make natural fertilizers. Local supply chains in food systems are affected by global shocks, such as recent price increases in fertilizer stemming from the COVID-19 pandemic [12, 42] and the Russia-Ukraine crisis [20, 23]. While finding local solutions like home gardens to help address critical supply issues and food insecurity is paramount, it is just as critical that the implementation of program adapt to local conditions based on feedback on the ground.

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Disclaimer

The views and opinions expressed in this paper are those of the authors and should not be attributed to IFAD, its Member States, or their representatives to its Executive Board.

Author contributions

TR contributed to the conceptualization, methodology, investigation, and writing (both the original draft preparation, as well as review and editing). JM and JG contributed to the conceptualization, funding acquisition, project administration, supervision, and writing (both the original draft, as well as review). SO contributed to the conceptualization. CA contributed to data curation and formal analysis.

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Availability of data and materials

The datasets analyzed during the current study are not publicly available due to the possibility of linking individuals to specific interviews, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethics approval was received from the Alliance Institutional Review Board. Written and oral consent were received by all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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References

- Adu-Baffour F, Daum T, Birner R. Governance challenges of small-scale gold mining in Ghana: Insights from a process net-map study. *Land Use Policy*. 2021;102:105271. <https://doi.org/10.1016/j.landusepol.2020.105271>.
- Akyildiz ST, Ahmed KH. An overview of qualitative research and focus group discussion. *Int J Acad Res Educ*. 2021;7(1):1–15. <https://doi.org/10.17985/ijare.866762>.
- Alive & Thrive. Nutrition Stakeholder Analysis: Bihar. Washington, D.C., USA: Alive & Thrive. 18 pp. 2014. https://www.aliveandthrive.org/sites/default/files/attachments/Nutrition-stakeholder-analysis_Bihar_11.11.pdf (last Accessed 07 Feb 2023).
- Aloo BN, Mbega ER, Tumuhairwe JB, Makumba BA. Advancement and practical applications of rhizobacterial biofertilizers for sustainable crop production in sub-Saharan Africa. *Agric Food Secur*. 2021. <https://doi.org/10.1186/s40066-021-00333-6>.
- Asirvatham R, Demi SM, Ezezika O. Are sub-Saharan African national food and agriculture policies nutrition-sensitive? A case study of Ethiopia, Ghana, Malawi, Nigeria, and South Africa. *Agric Food Secur*. 2022. <https://doi.org/10.1186/s40066-022-00398-x>.
- Baliki G, Brück T, Schreinemachers P, Uddin MN. Long-term behavioural impact of an integrated home garden intervention: evidence from Bangladesh. *Food Security*. 2019;11(6):1217–30. <https://doi.org/10.1007/s12571-019-00969-0>.
- Bergen N, Labonté R. “Everything is perfect, and we have no problems”: detecting and limiting social desirability bias in qualitative research. *Qual Health Res*. 2020;30(5):783–92. <https://doi.org/10.1177/1049732319889354>.
- Berretta M, Kupfer M, Shisler S, Lane C. Rapid evidence assessment on women’s empowerment interventions within the food system: a meta-analysis. *Food Agric Secur*. 2023. <https://doi.org/10.1186/s40066-023-00405-9>.
- Blee KM, Taylor V. Semi-structured interviewing in social movement research. *Methods Soc Movement Res*. 2002;16:92–117.
- Birner R, Sekher M. The devil is in the detail: understanding the governance challenges of implementing nutrition-specific programs on a large scale. In: Biesalski HK, Birner R, editors. *Strategies to improve nutrition quality*. Basel: World Review of Nutrition and Dietetics; 2018.
- Birner R, Cohen M, Ilukor J, Muhumuza T, Schindler K, Mbuligan S. Rebuilding agricultural livelihoods in post-conflict situations what are the governance challenges the case of Northern Uganda Uganda. Working paper No Strategy Support Program (USSP) 07. Washington: International Food Policy Research Institute; 2010.
- Bloem J, Farris J. The COVID-19 pandemic and food security in low- and middle-income countries: a review. *Agric Food Secur*. 2022. <https://doi.org/10.1186/s40066-022-00391-4>.
- Bushamuka VN, de Pee S, Talukder A, Kiess L, Panagides D, Taher A, Bloem M. Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. *Food Nutr Bull*. 2005;26(1):17–25. <https://doi.org/10.1177/156482650502600102>.
- CFNS (The Coalition for Food and Nutrition Security). Compendium of nutria-garden interventions in India. New Delhi, India. 43 pp. 2021. https://dietdiversity.communitygis.net/media/document_nutri/2021/04/24/Nutri_Garden_Compandium_for_web_25032021.pdf (last Accessed 07 Feb 2023).
- Cornwall A, Jewkes R. What is participatory research? *Soc Sci Med*. 1995;14:1667–76. [https://doi.org/10.1016/0277-9536\(95\)00127-5](https://doi.org/10.1016/0277-9536(95)00127-5).
- Cuanalo de la Cerda HE, Guerra Mukul RR. Homegarden production and productivity in a Mayan community of Yucatan. *Human Ecol*. 2008;36(3):423–33. <https://doi.org/10.1007/s10745-008-9166-5>.
- Ferdous Z, Datta A, Anal AK, Anwar M, Khan ASMMR. Development of home garden model for year round production and consumption for improving resource-poor household food security in Bangladesh. *NJAS Wageningen J Life Sci*. 2016;78:103–10. <https://doi.org/10.1016/j.njas.2016.05.006>.
- Galhena DH, Freed R, Maredia KM. Home gardens: a promising approach to enhance household food security and wellbeing. *Agric Food Secur*. 2013;2(1):1–13. <https://doi.org/10.1186/2048-7010-2-8>.
- Gertler P, Martinez S, Premand P, Rawlings LB, Vermeersch CMJ. *Impact evaluation in practice* International Bank for Reconstruction and Development. 2nd ed. Washington: The World Bank; 2016.
- Goodman, P.S. How a Fertilizer Shortage Is Spreading Desperate Hunger. 15 October 2023. *New York Times*. <https://www.nytimes.com/2023/10/15/business/nigeria-fertilizer-shortage.html>. (last Accessed 20 Oct 2023).
- Graham M, Audrey S, Barker M, Bond L, Bonelli C, Hardeman W, Moore L, O’Cathain A, Tinati T, Wight D, Baird J. Process evaluation of complex interventions: medical research council guidance. *Br J Med*. 2015. <https://doi.org/10.1136/bmj.h1258>.
- Habicht JP, Pelto GH. From biological to program efficacy: promoting dialogue among the research, policy, and program communities. *Adv Nutr*. 2014;5(1):27–34. <https://doi.org/10.3945/an.113.004689>.
- Hassen TB, Bilali HE. Conflict in Ukraine and the unsettling ripples: implications on food systems and development in North Africa. *Agric Food Secur*. 2024. <https://doi.org/10.1186/s40066-024-00467-3>.
- IFAD (International Fund for Agricultural Development). Odisha PTG Empowerment and Livelihoods Improvement Programme (OPELIP): Design Completion Report. 31 August. 197 pp. 2014a.
- IFAD (International Fund for Agricultural Development). Results and Impact Management System RIMS—First and Second level Results Handbook. April. 98 pp. 2014b. <https://www.carlep.gov.bt/wp-content/uploads/2016/11/RIMS-Handbook.pdf> (last Accessed 07 Feb 2023).
- IFAD (International Fund for Agricultural Development). 2015a. How to do—Integrated homestead food production (IHFP). <https://www.ifad.org/documents/38714170/40312880/How+to+do+note+-+Integrated+homestead+food+production+%28IHFP%29.pdf/044b8678-99b5-4555-b47d-c49f516ae01b?t=1555413937000> (last Accessed 09 Apr 2023).
- IFAD (International Fund for Agricultural Development). 2015b. President’s report – Proposed loan to the Republic of India for the

- Odisha Particularly Vulnerable Tribal Groups Empowerment and Livelihoods Improvement Programme. President's Report. Document EB 2015/114/R.11. 18 Mar. 32 pp.
28. IFAD (International Fund for Agricultural Development). Odisha Particularly Vulnerable Tribal Groups Empowerment and Livelihoods Improvement Programme: Mid-term Review. Report No. 5196-IN. 264 pp. 2019.
 29. IFAD (International Fund for Agricultural Development). Odisha Particularly Vulnerable Tribal Groups Empowerment and Livelihoods Improvement Programme: Supervision Report. Report No. 5559-IN. 154 pp. 2020.
 30. IFAD (International Fund for Agricultural Development). Odisha Particularly Vulnerable Tribal Groups Empowerment and Livelihoods Improvement Programme: Implementation Support Report, IN. 7 pp. 2021.
 31. Kafle K, Benfica R. Odisha particularly vulnerable tribal groups empowerment and livelihoods improvement programme (OPELIP): impact assessment baseline report. Rome: IFAD; 2017.
 32. Kafle K, Benfica R. Odisha particularly vulnerable tribal groups empowerment and livelihoods improvement programme (OPELIP): impact assessment baseline report. Rome: IFAD; 2018.
 33. Keatinge JDH, Yang RY, Hughes J, Easdown WJ, Holmer R. The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium development goals. *Food Secur.* 2011;3(4):491–501. <https://doi.org/10.1007/s12571-011-0150-3>.
 34. Kibet W, Habermann B. Net-mapping for low-emission food system development: Workshop on stakeholder mapping in Kapsabet Kenya. Nairobi: International Livestock Research System; 2023.
 35. Kim, S.S., Habicht, J.-P., Menon, P., and Stoltzfus, R.J. How Do Programs Work to Improve Child Nutrition? Program impact pathways of three nongovernmental organization intervention projects in the peruvian highlands. IFPRI Discussion Paper 01105. July, (2011), pp. 1–56.
 36. Lal R. Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic. *Food Secur.* 2020;12(4):871–6. <https://doi.org/10.1007/s12571-020-01058-3>.
 37. Litosseliti, L. (2003). Using focus groups in research. *Using Focus Groups in Research.* 1–104.
 38. Mbuya MN, Jones AD, Ntozini R, Humphrey JH, Moulton LH, Stoltzfus RJ, Maluccio JA. Theory-driven process evaluation of the SHINE trial using a program impact pathway approach. *Clin Infect Dis.* 2015. <https://doi.org/10.1093/cid/civ716>.
 39. Menon P, Ruel MT, Nguyen PH, Kim SS, Lapping K, Frongillo EA, Alayon S. Lessons from using cluster-randomized evaluations to build evidence on large-scale nutrition behavior change interventions. *World Dev.* 2020. <https://doi.org/10.1016/j.worlddev.2019.104816>.
 40. Mitchell R., and Hanstad T. Small home garden plots and sustainable livelihoods for the poor. FAO, Rome. LSP Working Paper 11. 50 pp. 2004. http://landwise-production.s3.amazonaws.com/2022/03/Mitchell_Small_homegarden_plots_and_sustainable_livelihoods_for_the_poor_2004-1.pdf (last Accessed 07 Feb 2023).
 41. Mockshell J, Birner R. Who has the better story? On the narrative foundations of agricultural development dichotomies. *World Dev.* 2020;135(2020):1–14. <https://doi.org/10.1016/j.worlddev.2020.105043>.
 42. Mockshell J, Ritter T. Applying the six-dimensional food security framework to examine a fresh fruit and vegetable program implemented by self-help groups during the COVID-19 lockdown in India. *World Dev.* 2025;175:106486. <https://doi.org/10.1016/j.worlddev.2023.106486>.
 43. Monks T. Operational research as implementation science: definitions, challenges and research priorities. *Implement Sci.* 2015;11(1):1–10. <https://doi.org/10.1186/s13012-016-0444-0>.
 44. Murray M. Narrative psychology and narrative analysis qualitative research in psychology: expanding perspectives in methodology and design. *Am Psychol Assoc.* 2003. <https://doi.org/10.1037/10595-006>.
 45. Murty PVVS, Rao MV, Bamji MS. Impact of enriching the diet of women and children through health and nutrition education, introduction of homestead gardens and backyard poultry in rural India. *Agric Res.* 2016;5(2):210–7. <https://doi.org/10.1007/s40003-016-0206-x>.
 46. Nielsen JN, Olney DK, Ouedraogo M, Pedehombga A, Rouamba H, Yago-Wienne FP. Process evaluation improves delivery of a nutrition-sensitive agriculture programme in Burkina Faso. *Mater Child Nutr.* 2018;14(3):12573. <https://doi.org/10.1111/mcn.12573>.
 47. Nkrumah B. Edible backyards: climate change and urban food security in Africa. *Agric Food Secur.* 2018. <https://doi.org/10.1186/s40066-018-0196-y>.
 48. Oakley A, Strange V, Bonell C, Allen E, Stephenson J. Process evaluation in randomised controlled trials of complex interventions. *Br Med J.* 2006. <https://doi.org/10.1136/bmj.332.7538.413>.
 49. Olney DK, Vicheka S, Kro M, Chakriya C, Kroeun H, Hoing L. Using program impact pathways to understand and improve program delivery, utilization, and potential for impact of Helen Keller International's homestead food production program in Cambodia. *Food Nutr Bull.* 2013;34(2):169–84.
 50. Olney DK, Leroy JL, Ruel MT. Evaluation of nutrition-sensitive programs. In: de Pee S, Taren D, Bloem M, editors. *Nutrition and health in a developing.* Cham: World Humana Press; 2017.
 51. Onwuegbuzie AJ, Dickinson WB, Leech NL, Zoran AG. A qualitative framework for collecting and analyzing data in focus group research. *Int J Qual Methods.* 2009;8(3):1–21. <https://doi.org/10.1177/160940690900800301>.
 52. OPELIP (Odisha PVTG Empowerment and Livelihoods Improvement Programme). Guideline on Nutrition Resource Center. 29 pp. 2019. <http://cms.opelip.org/DOWNLOADS/Notice/163.pdf> (last Accessed 07 Feb 2023).
 53. Palar K, Hufstедler EL, Hernandez K, Chang A, Ferguson L, Lozano R, Weiser SD. Nutrition and health improvements after participation in an urban home garden program. *J Nutr Educ Behav.* 2019;51(9):1037–46. <https://doi.org/10.1016/j.jneb.2019.06.028>.
 54. Patalagsa MA, Schreinemachers P, Begum S, Begum S. Sowing seeds of empowerment: effect of women's home garden training in Bangladesh. *Agric Food Secur.* 2015;4(1):1–10. <https://doi.org/10.1186/s40066-015-0044-2>.
 55. PHDMA (Poverty and Human Development Monitoring Agency). Report on state of food security and nutrition in Odisha. Planning and Convergence Department, Government of Odisha. 237 pp. 2020. <http://phdma.odisha.gov.in/sites/default/files/2021-01/PHDMA-Report-FSnN-Odisha-min.pdf> (last Accessed 07 Feb 2023).
 56. Phungwayo T, Kushitor SB, Koornhof L. Governance of food and nutrition security in Eswatini: an analysis of government policies and reports. *Agric Food Secur.* 2021. <https://doi.org/10.1186/s40066-021-00307-8>.
 57. PMU (Programme Management Unit). Nutrition activities proposed OPELIP 22.03.2014". Mar 22. 2014. Internal OPELIP document.
 58. PMU (Programme Management Unit). Guidelines for Implementation of Community Service Provider (CSP) Model. December 20. 2018. Internal OPELIP document.
 59. Pradhan A, Sathanandhan R, Panda AK, Wagh R. Improving household diet diversity through promotion of nutrition gardens in India. *Am J Food Sci Nutr.* 2018;5(2):43–51.
 60. Prost A, Harris-Fry H, Mohanty S, Parida M, Krishnan SK. Understanding the effects of nutrition-sensitive agriculture interventions with participatory videos and women's group meetings on maternal and child nutrition in rural Odisha a mixed-methods process evaluation. *Mater Child Nutr.* 2022. <https://doi.org/10.1111/mcn.13398>.
 61. Rawat R, Nguyen PH, Ali D, Saha K, Alayon S, Kim SS, Menon. mLearning how programs achieve their impact embedding theory-driven process evaluation and other program learning mechanisms in Alive and Thrive. *Food Nutr Bull.* 2013;34:212–25.
 62. Riessman CK. *Narrative analysis.* London: Sage Publications; 1993.
 63. Rossi PH, Freeman HE, Lipsey MW. *Evaluations: a systematic approach.* 6th ed. Thousand Oaks: Sage Publications; 2004.
 64. Ruel MT, Alderman H. Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition. *Lancet.* 2013;382(9891):536–51. [https://doi.org/10.1016/S0140-6736\(13\)60843-0](https://doi.org/10.1016/S0140-6736(13)60843-0).
 65. Rybak C, Mbwana HA, Bonatti M, Sieber S, Müller K. Status and scope of kitchen gardening of green leafy vegetables in rural Tanzania: implications for nutrition interventions. *Food Security.* 2018;10(6):1437–47. <https://doi.org/10.1007/s12571-018-0869-1>.
 66. Sanftenberg L, Dreischulte T, Härdtlein A, Kosub H, Gagyó I, Kurotschka PK, Gensichen J. Process evaluation in practice based research networks: a study protocol for a mixed-methods implementation study. *BMJ Open.* 2023;13(7):e065947. <https://doi.org/10.1136/bmjopen-2022-065947>.
 67. Schiffer E. Network analysis procedure, network analysis case study: Multistakeholder water governance in Ghana. In: Holland Jeremy, editor. *Tools for Institutional, political and social analysis of policy reform: A sourcebook for development practitioners.* Washington: World Bank; 2007.

68. SCSTRTI (Scheduled Castes and Schedule Tribes Research and Training Institute). Annual Outcome Survey of OPELIP. Bhubaneswar, Odisha, India. (2019a).
69. SCSTRTI (Scheduled Castes and Schedule Tribes Research and Training Institute). Evaluation of Bonda Development Agency. Mudulipada, Malkangiri District. Ed. Ota, A.B. (2019b).
70. Schreinemachers P, Patalagsa MA, Islam MR, Uddin MN, Ahmad S, Biswas SC. The effect of women's home gardens on vegetable production and consumption in Bangladesh. *Food Secur.* 2015;7(1):97–107. <https://doi.org/10.1007/s12571-014-0408-7>.
71. Shenton AK. Strategies for ensuring trustworthiness in qualitative research projects. *Educ Inf.* 2004;22:63–75. <https://doi.org/10.3233/EFI-2004-22201>.
72. Tama E, Molyneux S, Waweru E, Tsofa B, Chuma J, Barasa E. Examining the implementation of the free maternity services policy in Kenya: a mixed methods process evaluation. *Int J Health Policy Manag.* 2018. <https://doi.org/10.15171/IJHPM.2017.135>.
73. Temesgen H, Aweke CS. A scoping review on the impacts of smallholder agriculture production on food and nutrition security evidence from Ethiopia context. *Agric Food Security.* 2023. <https://doi.org/10.1186/s40066-023-00449-x>.
74. Webber S, Prouse C. The new gold standard: the rise of randomized control trials and experimental development. *Econ Geogr.* 2018;94(2):166–87. <https://doi.org/10.1080/00130095.2017.1392235>.

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