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Economic and empowerment impacts of millet processing and value-addition enterprises by women SHGs in tribal areas of Odisha, India (E²IMPART)

March 2025

Impact Evaluation Report 143

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This report, *Economic and empowerment impacts of millet processing and value-addition enterprises by women SHGs in tribal areas of Odisha, India (E^2IMPART)*, has been submitted as part of the Swashakt: Empowering Women's Collectives Evidence Program funded by the Bill & Melinda Gates Foundation. This report has been copy-edited and formatted for publication by 3ie. The 3ie editorial production team for this report comprises Mallika Rao and Akarsh Gupta.

All content, errors, and omissions are the sole responsibility of the authors. All affiliations of the authors listed in the title page were in effect at the time the report was accepted. Please direct any comments or queries to the corresponding author, Apurba Shee, at a.shee@gre.ac.uk

Suggested citation: Shee, Apurba, Aniema Atorudibo, and Zaki Wahhaj. 2025. *Economic and empowerment impacts of millet processing and value-addition enterprises by women SHGs in tribal areas of Odisha, India (E^2IMPART).* Impact Evaluation Report 143. New Delhi: International Initiative for Impact Evaluation (3ie). Available at: https://doi.org/10.23846/SWIE143

Badges earned: Preregistered 

Preregistration and the pre-analysis plan are available at: https://ridie.3ieimpact.org/index.php?r=search/detail-view&id=1092

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Economic and empowerment impacts of millet processing and value-addition enterprises by women SHGs in tribal areas of Odisha, India (E^2IMPART)

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Impact Evaluation Report 143

March 2025



Acknowledgments

This research was funded by the International Initiative for Impact Evaluation (3ie) under the Swashakt Program supported by the Bill & Melinda Gates Foundation. 3ie's Swashakt Program supports interventions to identify what works to enhance the viability, scalability, and returns of women's collective enterprises, and to promote women's economic empowerment. We thank all project partners, the Natural Resources Institute of the University of Greenwich, the Watershed Support Services and Activities Network, the Nabakrushna Choudhury Centre for Development Studies, the Indira Gandhi Institute of Development Research, Anglia Ruskin University, and the University of Kent. We especially thank the principal secretary and director of the Odisha State Department of Agriculture and Farmers' Empowerment for their support.

Summary

The primary goal of the E^{2}IMPART project was to generate evidence on the impact of services and support related to millet processing and value addition on female group-based enterprises. Evidence of this nature will enable the Odisha Millet Mission (OMM) to further develop its strategy for promoting millet enterprises through women's collectives. The evaluation estimates whether households and self-help groups with certain characteristics have greater capacity to take advantage of the support and services offered through the program; we believe this data will help the implementing agency to improve its targeting in future interventions.

We also evaluate the additional benefits of the OMM's value-addition activities within the program (provided primarily through new product development, such as recipes for high-value/commercial products such as biscuits, burgers, sandwiches, pastas, and noodles)—evidence that will assist the implementing agency to determine the optimal mix between support for millet processing and value addition in future interventions. Evidence from the OMM's intervention will also help to inform the development of other government initiatives to improve rural livelihoods through women's collectives.

While there is considerable evidence on the effects of interventions providing financial capital or training to women's groups (e.g., Barooah et al. 2019), to our knowledge there is little available evidence on interventions that provide enterprise development or support through product development and strengthening of market linkages. This is an important evidence gap that we aim to fill.

Regarding constraints to entrepreneurship, the literature (e.g., Giné and Mansuri 2014) suggests that social norms can restrict women's labor supply and participation in microenterprises. Women's participation in self-help groups can lead to their empowerment, helping them to overcome social constraints to participation in economic activities (or to retaining control of resultant income). These effects are even stronger when women have been members of a group for a longer period (Holvoet 2005; Swain and Varghese 2009). Therefore, it is important to determine whether, and to what extent, the capacity (maturity) of self-help groups is a factor in creating successful enterprises.

We use mixed methods to evaluate the effects of a program providing action-oriented training and capacity building to promote millet processing and value-addition enterprises among women's empowerment collectives. We employ a multi-arm cluster randomized controlled trial to study the impacts of providing support and services related to millet processing, as compared to providing support and services plus value addition, or no intervention at all (a pure control).

This report provides findings from endline survey data, including an evaluation of the intervention's effects on beneficiaries and their households. We find a sharp increase in entrepreneurial activities in the experimental arm that provided training on value addition through the development of new millet products (as well as training on postharvest processing of millets and strengthening market linkages for millet products). Female-owned enterprises grew by roughly 0.5 per household, and there were also increases in enterprise startup capital, revenues, and profits. Relatedly, we find positive empowerment effects on female self-help group members, including greater decision-

making roles in entrepreneurial activities, reduced working hours, and increased income control.

We do not see significant changes in entrepreneurial activities in the experimental arm in which training on value addition was not provided (though this arm did include training on postharvest processing and strengthening market linkages). However, we find positive effects on some empowerment outcomes (i.e., improved self-efficacy, reduced working hours) and improved household dietary diversity in this arm.

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Abbreviations

ITT	Intention-to-treat
MDE	Minimum detectable effect
OMM	Odisha Millet Mission
RCT	Randomized controlled trial
SHG	Self-help group
WASSAN	Watershed Support Services and Activities Network

1. Context and rationale for evaluation

Millets are important crops in arid and semi-arid areas in India and Africa; they are typically tolerant to extreme weather and can be grown with low input in low-rainfall areas. They are also nutritionally superior to major cereals in terms of protein, energy, vitamins, and minerals, making them pro-poor and pro-nutrition in nature. Millets have traditionally been a staple for millions of farm households in India and are a highly nutritious food source for poor rural communities.

However, due to inadequate postharvest technologies for processing and value addition, along with a lack of associated skills—particularly among women—millets are often perceived as inferior or regarded as a 'poor man's food.' Capacity building and skill upgradation in postharvest millet-processing technologies and value addition are crucial to improving economic and empowerment impacts, especially in tribal areas in Odisha.

Historically, major constraints to women's participation in millet enterprise include socio-cultural barriers (e.g., less appreciation for women’s farm work, more household responsibilities, lack of supportive services, and less mobility to markets), economic constraints (e.g., credit constraints, low prices), and technological constraints (e.g., lack of appropriate skills and women-friendly tools, tedious postharvest operations).

Women often carry out manual harvesting with traditional sickles and threshing on open floors, leading to grain contamination and quality issues. Affordable access to labor-saving, drudgery-reducing technology in the postharvest stage (such as threshers, graders, destoners, dehullers, and personal protective equipment) could significantly reduce their workload. However, the lack of investment in capacity building and business development has historically impeded promotion of millet enterprises.

The Odisha Millet Mission (OMM), initiated in 2017, aims to promote millet production and consumption, targeting five million beneficiaries. Its key objectives include increasing household millet consumption, improving crop productivity, promoting millet-processing enterprises, developing market linkages, and integrating millets into state nutrition programs. The OMM supports women collectives for millet processing and value addition and has shown promising results, with production, yield, and returns more than doubling since its inception. Due to such positive outcomes, the program expanded from 30 blocks in 2017–2018 to 72 blocks by 2019–2020.

The OMM has implemented and scaled up its model without any rigorous evidence; it is therefore important to establish a randomized controlled trial (RCT) to rigorously evaluate this at-scale project. Integrating this enterprise with collective action is an important way to increase business volume to a scale that could provide a viable opportunity for many value-chain actors.

In India, self-help groups (SHGs) have become alternative informal institutional structures that have now become pillars of government-sponsored poverty alleviation strategies. Enhancing the participation of women in millet processing through these groups will not only increase their purchasing power, but will empower them by facilitating their participation in decision-making and access to resources.

We contribute to the literature on off-farm enterprises in developing countries by using household surveys and an RCT design to provide rigorous estimates of the effects of millet processing and value addition on household entrepreneurship and welfare. The key evaluation questions to be addressed are: How does the provision of a millet-processing enterprise affect entrepreneurial activities among women in SHGs? How does it affect their decision-making authority within the household and household welfare? And what are the pathways to achieving economic and empowerment impacts?

1.1 Background

1.1.1 Millet cultivation in Odisha

Millet cultivation in Odisha plays an important role in the state's agriculture, especially in the tribal and rain-fed regions. Odisha's diverse agro-climatic conditions favor the growth of various millet crops, including finger millet (*ragi*), pearl millet (*bajra*), and little millet (*kutki*). These crops are ideal for Odisha's hilly and semi-arid regions because they withstand drought, require less fertilizer and pesticides, and grow in poor soil. This makes them essential for food security and the livelihoods of small and marginal farmers in the state.

Over the past five years, millet production in Odisha has increased dramatically, from 3,340 hectares in 2017–2018 to 52,230 hectares in 2021–2022—a 14-fold increase (APEDA 2022). Apart from self-consumption, a significant proportion of millet production goes toward the public distribution system. This is procured directly by the Odisha state government, which recently hosted the “International Year of Millet” convention in Bhubaneswar, generating significant global attention and momentum for millet.

1.1.2 The OMM

Since 2017, the OMM has been promoting millet production and consumption, with one of its key components being the promotion of millet enterprises through support for women’s collectives for millet processing and value-addition activities. The OMM has been implemented by the Odisha state government in collaboration with the Nabakrushna Choudhury Centre for Development Studies (state secretariat and research secretariat), the Watershed Support Services and Activities Network (WASSAN) (program secretariat), local NGOs, and community-based organizations.

The main goals of the OMM are to: (1) increase household millet consumption by 25 per cent to improve nutrition and create demand; (2) make millet farming more productive and profitable; (3) promote millet-processing enterprises at panchayat and block level to ease processing in households and for value-added markets; (4) develop millet businesses and connect them to markets, focusing on women entrepreneurs; and (5) include millets in state nutrition programs and the public food-distribution system.

The OMM’s support for women collectives in millet processing and value-addition activities began in the Kharif season of 2017, in 27 blocks across seven districts (Gajapati, Kalahandi, Kandhamal, Koraput, Malkangiri, Nuapada, and Rayagada). A baseline survey was conducted among 7,000 households in these blocks in October–November of that year, and the preliminary results have been encouraging. Production, yield, and returns from millets have more than doubled in treatment areas.

These results, combined with demand from the communities, led the government to increase the project scope from 30 blocks in 2017–2018 to 55 blocks (an addition of 25 blocks in the second phase) in 2018–2019, and then to 72 blocks (addition of another 17 blocks in the third phase) in 2019–2020.[1] The OMM model has been implemented and expanded without rigorous scientific evidence. To address this, an RCT was established to systematically evaluate the program's effectiveness.

1.1.3 SHG participation

The Odisha government has for many years promoted SHGs wherein women pool their regular savings to create a common fund, from which each member is eligible to receive loans. When SHGs mature, their members open a savings account with a local commercial bank and apply for loans to carry out productive activities. Through an SHG, members can access credit from local banks, learn about various income-generating activities, and acquire basic literacy and livelihood training.

Due to their high frequency of meetings, mutual trust, and peer support, SHGs can impact members beyond providing access to business capital. SHGs are village-based organizations; 10–15 SHGs form a cluster, and all clusters in a block (subdistrict administrative units) are facilitated as a block-level federation. These village- and block-level organizations provide a platform to facilitate collective action and link to income-generating opportunities.

Linking the OMM with SHGs is an important means of increasing business volume to a scale able to provide viable business opportunities for value-chain actors. Integrated microenterprises may have significant contributions to household income: preliminary findings show a net annual income in the range of INR 20,000– 40,000 from such an enterprise. This approach not only uses women’s time effectively but also provides them with control over income, which can influence their decision-making in the household. Moreover, this enterprise helps women to remain in the home rather than pursuing crop production or wage employment, which can impact children’s health, education, and nutrition.

2. Intervention

2.1 Description

2.1.1 Relationship between the E²IMPART project and the OMM

The relationship between the E²IMPART project and the OMM is complementary. The OMM supports community organizations and provides millet-processing machinery, while the E²IMPART project focuses on delivering action-oriented collective enterprise training.

We selected the Koraput district for our experiment for several reasons. Although Koraput had been part of the OMM implementation area since 2017, it had only received support for millet production. Postharvest processing and consumption-related activities had not yet begun in this district, making it an ideal location for our study (E²IMPART focuses on postharvest processing and value addition).

[1] Baseline report: http://ncds.nic.in/?q=node/475.

At the start of the E[2]IMPART project, none of the blocks included in our study had received support for millet processing and value addition, and thresher equipment had only been distributed to eligible SHGs under the OMM. We selected 86 villages from 10 blocks in Koraput district where threshers had been distributed to SHGs. From each block, we chose 8 or 9 villages, representing only a small proportion (approximately 3%) of the total villages in each block under this study. On average, this selection amounted to about 9 out of 300 villages per block. In each selected village, we identified two SHGs: one that owned the thresher and another that had access to one.

Following our experimental design, the selected villages were randomly assigned to treatment or control arms. It is important to note that all study SHGs, including those in the control arms, had access to the thresher provided by the OMM, and were at least three years old.

At the project's inception, we agreed with our implementation partner, WASSAN, to maintain the integrity of the proposed RCT design. This agreement was reinforced through subsequent weekly meetings throughout the project period. As the OMM program secretariat, WASSAN has the authority to determine the sites and timing of planned OMM interventions. The team ensured that the OMM did not initiate any new programs in either treatment or control villages during the study period. WASSAN took measures to ensure that each arm received only the type of support specified in the project research design.

Furthermore, our randomly allocated control villages were excluded from any support from this project or the OMM. However, we acknowledged in the pre-analysis plan that there could still be some processing and value-addition activities initiated by individuals. It is worth noting that these control villages began receiving the usual OMM support after the project concluded in December 2023.

Throughout the project period, several district- and block-level activities were conducted by the OMM in Koraput. These included women's campaigns, awareness camps, and training sessions on millet seed production techniques such as the system of millet intensification. However, we can confirm that our study villages were not exposed to these initiatives. After the project, WASSAN listed OMM activities that took place from April 2021 to December 2023. This review corroborated that none of our study villages had been exposed to any OMM activity during this period. This lack of exposure to programs other than the project treatment ensures the integrity of our experimental design and the validity of our findings.

2.1.2 E[2]IMPART project intervention

The intervention under examination is collective enterprise training to promote millet processing and value-addition enterprises undertaken by women SHG members in tribal areas in Odisha. The following are key components of the millet processing and value-addition enterprises:[2]

[2] Under the project, we promoted collective-based enterprises. Each SHG has a separate business/enterprise, allowing women to be involved in the sale and marketing of their produce. Each SHG provided with processing support has an enterprise that processes millet using a

1. **Technical support for postharvest and processing of millets.** To remove technological constraints, the OMM had provided millet thresher equipment to eligible SHGs (outside Koraput, the OMM distributed machineries such as threshers, graders, destoners, and dehullers). The E^{2}IMPART project provided operational support services including training of local mechanics identified by SHGs. The project also improved the design of current equipment supplied by the government through iterative learning and prototyping.
2. **Value addition through new product development**. The E^{2}IMPART project worked on three broad millet consumption areas:
    - Household-level consumption: Millets are traditionally consumed at the household level as gruel or *pejo* (porridge) or *javu* (drink), or in roasted/popped form in Odisha. These forms of consumption are generally coarse. It is also important to develop new recipes that are more acceptable to the younger generation. Postharvest machinery is useful to ensure that clean and dirt-free millet is available for consumption at the household level. An increase in millet consumption at the household level will improve the nutrition and immunity of households, especially women. Improving the immunity levels of the community is particularly important in times of COVID-19.
    - Community-level consumption: Traditionally, millets are means of exchange during harvests and festivals (e.g., village festivals, local markets [*haats*], street vendors). In addition to household consumption, there are many dishes or recipes made during community events or in local markets. There is also a need to develop new products and improve existing ones at this level.
    - Commercial or high-value product consumption: Youth, especially in semi-urban and urban areas, now have the greatest interest in different kinds of high-value/commercial products (e.g., biscuits, burgers, sandwiches, pastas, noodles). The project worked with the community and developed products suitable for local tastes. Knowledge gained was linked to local value-addition units (e.g., biscuit-making units). Further state-level engagement was facilitated with corporate, high-value product manufacturers on this score.

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thresher to produce and sell clean millet grains. Each SHG provided with value-addition support has an enterprise to sell value-added products, which also creates a form of competition among the groups.

The main equipment for value addition is pulverizers. SHG members use these to make *ragi* and fermented products such as *pejo* or *javu*, which they sell in the local market. From the millet powder (flour), they also make various foods such as *ragi idli*, *dosa*, *chakuli*, *pokoda*, and others, for the local market. Additionally, they make basic cakes that don't require an oven, using utensils and direct heating instead.

The operational context of the millet processing and value-addition enterprises is as follows. Depending on the location and the availability of markets, women in SHGs can either sell directly in local markets, or supply to centralized procurement through women's federations/farmer producer organizations. For processing enterprises, women in SHGs can sell their clean millet grains for: (1) government procurement, (2) informal markets, and (3) through women's federations/ farmer producer organizations. For value-addition enterprises, women in SHGs can sell their value-added products to: (1) semi-urban and urban markets using kiosks or tiffin centers, and (2) SHG federation/farmer producer organizations or private-sector actors.

3. **Enterprise development support**. In addition to drudgery-reducing equipment, collective-based enterprise development support is also necessary. Similarly, SHGs establishing enterprises to develop high-value products require separate business development.
4. **Gender-responsive training and capacity building**. The project provided eight training modules on enterprise development around millet processing and value addition. It also facilitated exposure visits for participating women to learn from other successful millet-processing and value-addition activities.
5. **Innovation nutrition profiling, and market linkages**. As one of the project components is to enhance women's nutritional security during product development, it is important to perform nutritional profiling of millet landraces and millet products. Although different landraces can belong to the same millet species, there is significant variation in the nutritional profile of various landraces. For example, the calcium content of finger millet can vary between 100–700 units per 100 grams, based on their landraces. Therefore, under innovation, the project took up nutritional profiling of millets to support the development of value-added products.

Figure 1: Gender-sensitive training program



Figure 2: Millet processing and value-addition activities by women's SHGs



Capacity building through training and exposure visits

Gender-sensitive training program

One of the key innovations in this project is the development and delivery of action-oriented collective-enterprise training programs. The research and implementation teams invested significant time in their joint development throughout the project period. The process for each module was rigorous and iterative:

1. Initial drafting of the training program;

2. Organization of a training-of-trainers session, attended by both research and implementation teams; and
3. Revision of module materials, incorporating feedback from participants and the project team.

The resulting materials are innovative and easily communicable, utilizing anecdotal examples, videos, storytelling, and pictorial planning charts. We drew upon our extensive fieldwork experience from organizations such as IFPRI, PRADAN, and ILO to create these resources.

The training modules used a participatory adult-learning approach by encouraging participants to take part in group discussions, explore learning together through roleplays and case studies, and share their good and bad experiences. It is important to note that such a comprehensive training program did not previously exist under the OMM program. In fact, the OMM has now begun using these materials to effectively promote millet-processing and value-addition enterprises to wider areas only after the conclusion of our project. This underscores the innovative nature of our approach and its potential for wider application in similar contexts.

The following table depicts the training imparted to respective treatment arms. We have meticulously documented all training modules and produced two separate booklets for the processing and value-addition study arms (available upon request).

Table 1: Training imparted to respective treatment arms

Training module number	**Module name**	**Applicability**
1	Connecting millets to roots; Health benefits of millets; Introducing the OMM	Common modules were provided to Treatment arms 1 and 2
2	Importance of collectivization; Mission Shakti; Mission Shakti/OMM convergence	
3	Collective vision-building for millet-based enterprises (threshing and pulverizer units) and market linkages	The module has specific content to be imparted separately to Treatment arms 1 and 2 (processing support for Arm 1 and processing and value-addition support for Arm 2)
4	Business development plan for women's SHG enterprises (processing; processing and value addition)	
5	Financial management plan for women's SHG enterprises (processing, processing and value addition)	
6	Recipe training for value-addition enterprise	Treatment arm 2
7	Bookkeeping training for accountants	Accountants in all 116 SHGs Treatment arms 1 and 2
8	Refresher of all modules	Common modules were provided to both Treatment arms 1 and 2

Module 1: Connecting millets to roots; health benefits of millets; introducing the OMM
The purpose of this module is to promote awareness among participants of the

importance and nutritional benefits of millets and the millets revival program. The module includes the following broad components: millets, their existence and importance; existing varieties of millets and cultivation practices being followed; health benefits of millets and their current consumption status and nutritional advantages over other cereals; the revival of millets; and an introduction to the OMM.

Module 2: Importance of collectivization; Mission Shakti; convergence of Mission Shakti and the OMM
The purpose of this module is to build an understanding of Mission Shakti, its importance, and its convergence with the OMM. Its broad components are: understanding the reason for and importance of collectivization, sharing glimpses of successful Mission Shakti SHGs; the Mission's emergence, vision, mission, objective, and features; the spread of Mission Shakti; OMM enterprises; roles and responsibilities of stakeholders; and deliverables of women's collectives.

Module 3: Collective vision-building for millet-based enterprises
The purpose of this module is to build a vision around millet-based processing enterprises, which, in the long run, would prove beneficial for the sustainability of these enterprises. The broad components covered are: understanding the importance of a vision in one's life's journey; sharing stories of women's SHG-led collectives' transformation; visioning-building exercises around the OMM enterprises (e.g., threshing) and units with the help of a few documentaries of established women's SHG-led enterprises; market and industry linkages through farmer-producer organizations and with local and urban buyers for millet-processing enterprises. The lengthier training module for Treatment arm 2 will cover processing and value addition, including vision-building exercises around OMM enterprises (namely, millet shakti tiffin centers, millets on wheels, millet shakti café units) with the help of a few documentaries of established women's SHG-led enterprises.

Module 4: Business development plan for women's SHG enterprises
The purpose of this module is to establish a proper business plan for the SHG-led millet-processing enterprises. Its broad components include: group exercises to understand the major components of the SHG's enterprise (threshers) and to see the entire business in a chronologically flowing sequence; producing a detailed business development plan for their respective enterprise comprising all the above-mentioned components and the SHG member responsible for each. The lengthier training module for Arm 2 will cover processing and value addition. This will include a group exercise to understand the major components of the SHG's millet value-addition enterprises (millet shakti tiffin centers, millets on wheels, and millet shakti café units).

Module 5: Financial management plan for women's SHG enterprises
The purpose of this module is to build an understanding of finances and bookkeeping among members of the SHG-led enterprise. The major components include: the introduction of bookkeeping formats such as daily business tracking, monthly or weekly meeting attendance, a minutes register, and a cash book; and practical demonstration for work, delivery, and transaction. The lengthier training module for Arm 2 will cover processing and value addition.

Module 6: Recipe training for value-addition enterprises
The purpose of this module is to build the capacity of SHG members around innovation in the development of millet recipes that would be beneficial for setting up and running their value-addition enterprises. Its major components encompassed include practical preparation of some locally demanded millet recipes (both perishable and those with a longer shelf life). This is provided only to Arm 2.

Module 7: Bookkeeping training for SHG accountants
The purpose of this module is to equip the bookkeepers of SHG enterprises in systematic recordkeeping, preparation of account statements, and facilitating audit and management information systems for business operations.

Module 8: Refresher training on all modules
The purpose of this module is to provide a comprehensive presentation of all components in Modules 1–7. This is a useful opportunity to revise the content and discussions from all previous modules.

Tools and methods used in trainings
The elements used in trainings to ensure they are effective are as follows:

- Information education communication materials were developed for the first two modules, including:
  - Explanation of Mission Shakti, its objectives, structure, and spread
  - Overview of Mission Shakti and OMM convergence activities
  - Exercise to envision setting up an enterprise
- Short videos and documentaries such as:
  - System of millet intensification
  - Mission Shakti objective and spread
  - Successful Mission Shakti women's SHG enterprises
- Games such as:
  - Passing the ball
  - Fire in the forest
  - Stone bucket
  - Stick breaking
- Roleplay around health benefits of millets for children and women of reproductive age
- Subgroup activities leading to plenary discussion around:
  - Cultural significance of millets
  - Nutritional benefits of millets
  - Benefits of collectivization
  - Millet farming
  - Women's SHG-led enterprises
- Songs for collective strengthening

Gender-sensitive and action-oriented training
All the capacity-building training modules are specially designed, keeping in view the following aspects to make them gender-sensitive:

- Women's collectives are emphasized as the primary focal point for the promotion of women's SHG enterprises.
- Trainings are conducted in the village (in anganwadi centers and community

halls) to ensure ease of attendance.

- Training timings are scheduled in accordance with the needs of SHG members to ensure their daily work routines are not considerably affected.
- Special care is being taken to ensure the availability of creches for small children and toddlers accompanying their mothers to the training, with a specially designated caretaker from the same village.
- To ensure nutritional security, small children and toddlers of women participating in the training are fed newly innovated millet recipes (e.g., muffins) under the supervision of the creche caretaker.
- To ensure action after the training session, participants share their key takeaways and their plans to use or include them in their day-to-day lives. Some now are including millets in their daily diets, reviving the cultivation of millets on their land, reviving and working on strengthening their collectives and SHGs, and envisioning their collectives and SHGs starting up enterprises beyond their standard savings and credit activities.

Training evaluation and feedback

To ensure the retention of knowledge, visually-aided evaluation questionnaires have been developed and used in the trainings, which are resulting in enhanced interest in participation, as many participants are not comfortable with reading and writing.

Feedback (both verbal and written) is collected at the end of each training, regarding:

- Training content
- Behavior and friendliness of facilitator
- Creche facilities
- Training environment and food arrangements
- Place of training and travel to the venue

Exposure visits

Community exposure visits to millet-processing and value-addition sites were planned to promote practical learning about millet-processing technologies and value chains, and to provide hands-on training on millet processing and batch processing, as well as related challenges, to SHG members. Separate exposure visits sites were planned to consider both treatment arms.

Table 2: Exposure visits for processing arm

Sl No	Unit name	Place of positioning	State	Works around
1	Manyam grains	Anakapally	AP	Processing (sorting, grading, destoning) of millets
2	Trisakti women's SHG federation	Baramunda, Bhubaneswar	Odisha	Processing (sorting, grading, destoning) of millets

Table 3: Exposure visits for processing and value-addition arm

Sl No	Unit name	Place of positioning	State	Works around
1	CFTRI	Mysore	Karnataka	Millet products
2	Saktimayee	Rental colony,	Odisha	Mixture, *nimki, arisa, karanji, seo,*

Sl No	Unit name	Place of positioning	State	Works around
	women's SHG federation	Bhubaneswar		*ganthia, badam pokoda, ladoo, chhatua*, outlet
3	Krishna SHG	Keonjhar	Odisha	THR (*ladoo* mix making), café
4	Baba Simleshwari SHG	Bangiriposi, Mayurbhanj	Odisha	*Ragi khurma* making, food truck
5	KVK	Jagdalpur	CG	
6	Trisakti	Baramunda, Bhubaneswar	Odisha	*Murku, arisa*, same as *shaktimayee* but no mixture
7	Dibyajyoti SHG	Sundargarh	Odisha	Biscuit-making, cake, café, food truck, tiffin center

The exposure visits have also been made gender-sensitive through special provisions catering to SHG members' needs, such as:

- A preliminary meeting with expected participants and their families about the exposure visit on subjects such as visit objectives, destination and duration, travel plans, persons accompanying them, food, and lodging arrangements.
- Special arrangements for transporting participants to and from their villages to ensure their comfort and safety.
- Providing caretakers for children while mothers are in learning sessions.
- Paying special attention to carrying adequate rations (dry food, water) and baby food during travel.
- Inclusion of first aid kits (e.g., supplies to address accidents or health issues.
- Providing comfortable travel (by OSRTC Volvo bus) and accommodation and healthy food facilities at the destination.

The women said this exposure was very educational, as they hadn't yet observed such processing units. They were happy to gain a chance to operate heavy machinery and were glad to see a female workforce at Manyam grains, with whom they were able to interact. The women discussed the idea of operating a women-led, millet-based processing enterprise in their village, and intended to have meetings regarding this to further develop the idea once they reached their village.

2.2 Theory of change

In figure A1, we present the project theory of change. The key question we ask is whether and how does millet processing improve: (1) household income (especially among women); (2) women's empowerment and contributions to household decision making; and (3) household education and nutrition outcomes? The impact pathway diagram links actual needs to programmatic inputs, expected outputs, outcomes, and long-term impacts.

The principal problem is the existing gender gap in entrepreneurship and the lack of quality employment for women. This creates a need for women-focused and group-based microenterprises. The millet processing intervention with SHGs aims to increase business volume to make the enterprise viable for many value chain actors.

This integrated microenterprise may have a significant contribution to household income, as preliminary findings show a net annual earnings from such an enterprise is

approximately INR 20,000–40,000 (Mishra 2020). This approach not only uses women's time effectively but also gives them control over income. In particular, the adoption of advanced millet-processing machinery and methods will reduce drudgery work for women and improve their time use, which can impact children's health, education, and nutrition.

In addition, participation in SHGs may increase women's access to credit, which may be used in productive activities, including millet processing. This productive investment can increase household income and improve household consumption-smoothing over time. The collective actions from both the SHGs and the millet-processing enterprises, along with women's control over income, can improve women's ability to make decisions in the household (as discussed above), and this factor may interact with other impact pathways. For example, the existing literature indicates that improved decision-making ability within the household can enable women to allocate more resources towards child health, education, and nutrition.

Overall, this approach may result in a positive effect on household and women's income and other welfare indicators, while also improving overall household food security and nutrition.

2.3 Monitoring plan

Various gender-sensitive training modules and exposure visits have been developed and finetuned. In December 2021 (immediately after finishing the baseline household survey), WASSAN initiated the action-oriented training programs. The research team monitored implementation of the training modules and exposure visits. The specific implementation activities tracked included:

- Delivery of specific training modules and exposure visits for millet processing and value addition. The team tracked feedback and knowledge retention from these programs.
- Building institutions and services to improve market effectiveness. WASSAN established market linkages for millet processing and value-added products.
- Supporting the project's research, monitoring, and evaluation effort.
- Working with the SHG members to select millet recipes.
- Nutrition profiling was conducted to brand millet products and recipes.

We conducted a process evaluation to check implementation fidelity to assess whether the implementation has been consistent with the "reach, benefit and empower framework" and conducted as planned. We followed three main steps: (1) implementation documentation—to tally the activities and process of program implementation; (2) implementation assessment—to monitor the program by collecting data and making corrections to the process; and (3) implementation evaluation—to retrospectively determine whether the program was implemented as designed.

The primary data used for the process evaluation was administrative information collected during the intervention, including information on the participation of SHG members in training sessions, short surveys of training session attendees, and reports prepared by trainers and training supervisors. The overall conclusion of this evaluation was that implementation fidelity had been ensured throughout the intervention, with high

uptake throughout the intervention period. Participants also demonstrated good understanding of the key knowledge outcomes and expressed high levels of satisfaction with the training.

The following monitoring indicators were collated and recorded on a quarterly basis, by the experimental arm, during the implementation period:

1. Number of program beneficiaries;
2. Number of enterprise-development training sessions conducted;
3. Number of enterprise-development training refreshers conducted;
4. Number of beneficiaries that attended the training sessions;
5. Total sales;
6. Gross profit;
7. Net profit;
8. Total financial investment in business equipment;
9. Number of new millet products launched for individual and community consumption;
10. Number of new millet products launched for commercial and high-value consumption;
11. Participant performance on the quiz conducted at the beginning and end of training sessions; and
12. Qualitative feedback obtained from participants at the training sessions.

3. Evaluation

3.1 Primary and secondary questions

The primary research questions are as follows:

1. How does the provision of services related to millet processing affect entrepreneurial activities (e.g., business investments and income generation) among women in SHGs? What is the additional effect of services related to value addition on these outcomes?
2. How does the provision of services related to millet processing and value addition affect household welfare (e.g., nutrition, health, and education of children)?

The secondary research questions are as follows:

1. How does the provision of services related to millet processing and value addition affect intermediate outcomes such as SHGs' social capital, women's time allocation to business and household activities, and women's decision-making authority within the household?
2. Does the provision of services related to millet processing and value addition have differential effects on women depending on initial levels of social capital within SHGs, attitudes towards enterprise and uncertainty, and other socioeconomic characteristics of the household?

3.2 Design and methods

To address Questions 1 and 2, we defined the treatment arms as follows:

- Treatment arm 1: Provision of support and services related to enterprise development including a revolving fund, training and capacity building, and developing market linkages for millet processing among SHG members.
- Treatment arm 2: All the support and services mentioned in Treatment arm 1, as

well as value addition through the development of new products (high-value products and recipes such as biscuits, cakes) for SHG members.
- Control arm: No intervention.

The study SHGs in all three arms, including the control arm, have access to machinery such as threshers, graders, destoners, and dehullers provided by the OMM.

To address Question 3, we included various intermediate outcomes in the women's questionnaire in the household survey; these were collected during both the baseline and endline surveys.

To address Question 4, we collected various information on social capital within SHGs, as well as household socioeconomic characteristics. To investigate heterogeneity in treatment effects, we interacted measures based on these experiments and other socioeconomic characteristics recorded at baseline, with treatment dummies in a regression framework.

The evaluation design provides estimates on the additional benefits (in terms of female entrepreneurship and household welfare) derived from the implementing agency's value-addition activities, and consequently will help to design more effective programs in the future. It will yield estimates on whether households and SHGs with certain characteristics have a better "capacity" to take advantage of the support and services offered through the program, which, we believe, will help the implementing agency to improve its targeting in future interventions. We investigate whether the capacity (maturity) of SHGs is a factor in a successful enterprises by conducting heterogeneity analysis based on the age of the SHG at the time of the intervention.

The evaluation design is presented in figure B1, where the eligibility criteria for program participation and the sampling criteria for the baseline and endline surveys are identical across all treatment/control arms.

Immediately after the baseline survey, WASSAN implemented the above-mentioned activities following the project's RCT design. The enterprise development support elements (including sourcing revolving funds, training and capacity building, market linkages with local and urban buyers, and developing new products) were provided throughout the remainder of the project. The timeline of project activities is provided in figures C1 and C2.

3.3 Sampling and data collection

3.3.1 Sampling

Table 4: Selected sample frame

	Blocks	Thresher ownership (no. of SHGs)	Thresher access (no. of SHGs)	Number of revenue villages
Koraput	Boipariguda	9	9	9
Koraput	Borigumma	10	10	10
Koraput	Dasmanthpur	9	9	9
Koraput	Koraput	8	8	8

	Blocks	Thresher ownership (no. of SHGs)	Thresher access (no. of SHGs)	Number of revenue villages
Koraput	Kundra	9	9	9
Koraput	Lamtaput	9	9	9
Koraput	Laxmipur	7	7	7
Koraput	Nandapur	9	9	9
Koraput	Pottangi	7	7	7
Koraput	Semiliguda	9	9	9
Total	**(10 blocks)**	**86**	**86**	**86**

Statistical power

The power calculation is a major component of program evaluations that indicates the sample size required to detect a given impact. It is important to improve the efficiency of the experimental design. The null hypothesis is defined as having no treatment effect, while the alternative hypothesis is defined as a specific detectable effect size. The idea behind optimal power is that the sample sizes must be large enough such that: (1) the design does not falsely reject the null hypothesis that the treatment and control outcomes are equal (commit a type 1 error); and (2) the design does not falsely accept the null hypothesis when there is the actual difference (commit a type 2 error).

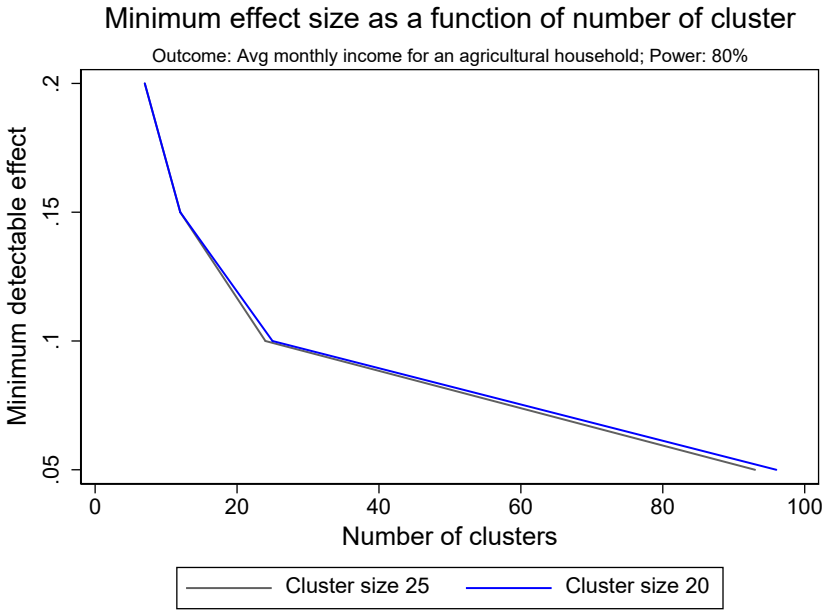
Before the baseline data collection, we conducted a power calculation using the "sub-state level estimation on income and indebtedness of agricultural households of rural Odisha" data by the National Sample Survey Office in Odisha's Directorate of Economics & Statistics, which covers our proposed district of Koraput. The sample design would allow us, at 80 per cent power, to detect impacts of millet processing and value-addition enterprises on income generation (as predicted by the theory of change) that are no smaller than 10 per cent of the initial income level of an agricultural household.

We believe that the minimum detectable effect (MDE) of the program will be no smaller than 10 per cent. The mean and standard deviation of a monthly income of an agricultural household in Rayagada district (which neighbors Koraput and has similar characteristics) are INR 2,940 and INR 735, respectively. We assume that the significance of the treatment effect will be determined using a t-test.

We also assume the intra-cluster correlation to be about 0.2. Figure 3 below shows the minimum effect size (5–20%) that can be detected for different combinations of the number of clusters (the black line corresponds to the number of clusters for the cluster size of 25, while the blue line corresponds to the number of clusters for the cluster size of 20).

As shown in the figure, an increase in the number of clusters, especially from a low number of clusters, has a very high impact on power. We see that the optimal number of clusters will be about 23, which will detect a minimum 10 per cent increase in household income with adequate statistical power (80%). To further increase statistical power, we selected 29 or 28 clusters per arm in our sampling design. Since we selected 20 households from a village, the total sample size in an RCT arm is about 580. After the baseline household survey, we conducted the power calculation with various other outcome indicators presented in Table 2.

Figure 3: Sample design using National Sample Survey Office data based on average monthly income for an agricultural household in Rayagada



Note: As can be seen, with a 10 per cent minimum detectable effect and adequate statistical power (80%), our optimal number of clusters per arm is about 23. Since we select 20 households from a cluster and 28 or 29 clusters per arm, the total sample size in an RCT arm equals 560 (in the control arm) or 580 (in each of the treatment arms).

Baseline power calculation

We conduct power calculations for each baseline outcome variable using summary statistics from the baseline data. Using a power of 0.80, we find that most MDEs are below 20 per cent of the baseline mean, which is consistent with our initial power calculations. The MDEs for some variables are much greater than 20 per cent, but this is primarily because the baseline values for these variables are quite small.

Table 5: Baseline power calculations for each outcome variable

Outcomes	Mean	ICC	MDE	MDE/MEAN
Primary outcomes				
Total household income (INR)	49,979	0.1082	16,691	0.33
Women's enterprise income (INR)	453.9	0.0281	1,460	3.22
Total invested in business (INR)	2,118	0.1275	4,556	2.15
Household dietary diversity score (index)	9.428	0.1358	0.482	0.05
Access to productive resources	1.263	0.04851	0.3424	0.27
Control sale of productive resources (INR)	1.152	0.04106	0.2718	0.24
Control purchase of asset, resources	1.114	0.04264	0.266	0.24
# of groups with woman in lead role	0.1965	0	0.06842	0.35
Time (min) on own business	66.46	0.07424	32.71	0.49
Time (min) on farming/livestock	192.4	0.2343	71.67	0.37
Time (min) on childcare	34.07	0.077	17.39	0.51
Time (min) on sick/elderly care	1.617	0	1.952	1.21
Time (min) on childcare while doing other activities	114.5	0.08345	61.56	0.54
Prop. activities over which woman has income control	0.2748	0.05154	0.04609	0.17

Outcomes	Mean	ICC	MDE	MDE/MEAN
Secondary outcomes				
Value of food consumption (INR)	1,101	0.07599	160	0.15
Food security index	1.381	0.0845	0.7319	0.53
Food worry pre. 7 days	0.296	0.05648	0.1111	0.38
Life satisfaction today	0.7457	0.01479	0.0833	0.11
Life satisfaction in 5 years	0.76	0.01249	0.0803	0.11
SHG decisions - members participate	0.7094	0.08463	0.1239	0.17
SHG purchases - members participate	0.5354	0.00773	0.09028	0.17
SHG number of members	10.69	0.5599	0.8329	0.08
Volume of loans from SHG (INR)	3,342	0.1441	3,601	1.08
Volume of bank loans (INR)	943	0.1943	2,978	3.16
Prop. of child. in age-appropriate education	0.8648	0.0957	0.08481	0.10
Enterprise outcomes				
Number of household enterprises	0.134	0.123	0.1169	0.87
Number of female enterprises	0.02621	0.681	0.1008	3.85
Loans from banks (INR)	79.31	0.03785	242	3.05
Loans from informal sources (INR)	55.39	0.00027	277.5	5.01
Sales revenue from HH enterprise (INR)	18,202	0.0215	16,080	0.88
Profits from HH enterprises (INR)	7,056	0.01579	6,406	0.91
Business startup capital (INR)	5,496	0.02506	6,667	1.21

Note: ICC = intra-cluster correlation. MDEs are calculated assuming a power of 0.80 and alpha equal to 0.05.

Assignment to treatment

The eligibility criteria for program participation are identical across all treatment/control arms (SHGs aged 3+ years). From the above 86 selected villages, we randomly assign 29 villages to Treatment arm 1, another 29 villages to Treatment arm 2, and the remaining 28 villages to the control arm. Before the baseline data collection, we conducted the following balance check using SHG administrative data.

Table 6: Balance check after random treatment assignment and before baseline

Variable	Control group (n = 54) mean/SE	Treatment group (n = 56) mean/SE	Treatment group (n = 56) mean/SE	t-test diff (1)-(2)	t-test diff (1)-(3)	t-test diff (2)-(3)	Normalized diff (1)-(2)	Normalized diff (1)-(3)	Normalized diff (2)-(3)
Size of SHG	10.074	10.357	10.071	-0.283*	0.003	0.286	-0.321	0.003	0.234
	[0.069]	[0.150]	[0.174]						
Age of SHG	8.541	7.951	8.078	0.589	0.463	-0.127	0.161	0.106	-0.033
	[0.565]	[0.418]	[0.612]						

Household selection

The sampling criteria for the baseline and endline surveys are identical across all treatment/control arms. In each of the sampled villages, there are two SHGs: one that owns a thresher and another that only has access to a thresher through the other SHG. We included households of all members of both SHGs in the baseline and endline surveys. On average, the SHGs have 10 members, typically with no more than one SHG member per household. The total sample size is about 1,679 households.

3.3.2 Survey instruments

During the baseline and endline surveys, we conducted two separate interviews within each household. One was with the household head (as identified by the household), during which we asked questions regarding assets, income, consumption, loans, savings, and other household-level information.

The other interview was with a female household member who belongs to the SHG. We asked about her involvement in village women's groups and her networks, and her involvement in decision-making, safety, mobility, and self-efficacy.

There were some differences between the baseline and endline survey questionnaires. The baseline questionnaire section on the impacts of COVID-19 was dropped from the endline questionnaire. Two new sections were added to the endline questionnaire to better capture the program effects on social capital within the SHGs and social networks of SHG members.

Table 4 lists the questionnaire modules, including differences between the two rounds.

Table 7: Baseline and endline questionnaire modules

MILLET ODISHA PROJECT QUESTIONNAIRE HOUSEHOLD AND INDIVIDUAL SURVEY MODULES 2021–2023
Household questionnaire: 11 modules
Section A: Basic household information
Section B: Household membership
Section C: Household income and expenditure on agriculture and livestock (including procurement of *ragi*)
Section D: Household income from casual or MGNREGA labor
Section E: Household income from other sources (salaried or in-kind)
Section F: Household enterprises
Section G: Household's access to social schemes
Section H: Household savings and loan
Section I: Subjective welfare and food security
Section J: Food consumption
Section K: Impacts of COVID-19 (baseline questionnaire only)
Women's questionnaire: 12 modules
Section L: Individual identification and information
Section M: Women's enterprise and income
Section N: Women's role in decision-making
Section O: Access to productive capital (production and consumer assets)
Section P: Women's savings and access to financial services
Section Q: Time allocation
Section R: Groups and collectives, including SHGs
Section S: Physical mobility
Section T: Intrahousehold relationships
Section U: Autonomy in decision-making and attitudes about domestic violence
Section V: Social capital (endline questionnaire only)
Section X: Investment/trust game (endline questionnaire only)

3.3.3 Survey implementation

Recruitment of enumerators and supervisors

The project team contracted survey agency KPS India Private Limited to conduct the baseline data collection. KPS dedicated a team of 22 field professionals comprising 15 enumerators, three field supervisors, two field coordinators, and two field managers to ensure the assignment was completed smoothly and on time**.** KPS relied mainly on its local knowledge about high-quality and reliable survey supervisors and enumerators in its selection process.

The minimum qualification criteria for supervisors were at least three years of experience in managing or conducting household surveys, as well as having served as enumerators themselves. The minimum qualification for an enumerator was a university degree, primarily in social sciences or economics. Based on knowledge of the local context, KPS was able to identify and recruit 15 Odia-speaking enumerators with good experience in data collection for household surveys.

Enumerator training

For the baseline survey, classroom training was held over three days (October 11–13, 2021) in Koraput to help participants understand the questionnaire, its objectives, sections, logical sequences in the SurveyCTO® application, and flow. In addition, project partners at the University of Greenwich and WASSAN joined the training session online or offline. A similar enumerator training was conducted in the first week of October 2023 for the endline survey.

The training started with an Introduction to the project and the survey objective. Thereafter, enumerators were taken through each module of the questionnaire and guided as to the best way to ask the questions. This training was first conducted with a paper questionnaire translated into Odia language. An interactive mode was adopted, wherein enumerators were welcome to ask questions or even make suggestions. Some of these discussions led to changes in the questionnaire.

After the enumerators had a solid understanding of the questionnaire, the training shifted from the paper questionnaire to computer-assisted personal interviewing. The KPS programmer explained to the team the modalities of electronic data collection, narrowing specifically to the SurveyCTO® program. Thereafter, the enumerators went through the training using tablets. During this phase, interpretation was also undertaken, and the enumerators were guided through the best way to ask the questions in the local language.

Field pilot

A pilot survey was conducted in Dumuriguda and Dumuriput villages (outside our project operational area) to test the questionnaire, with each enumerator administering the entire questionnaire. This gave the enumerators first-hand experience with the questionnaire in a real-world setting. They were encouraged to record their positive or negative observations to share on the following day (October 15), when each enumerator debriefed and discussed their observations.

All feedback was considered, and changes were made to the questionnaire and the SurveyCTO® application, with mutual consultation with the Principal Investigator and other team members. The second round of the pilot survey was conducted in Duruguda

and Deula villages on October 16. The procedures for observation and debriefing were repeated following the first pilot survey. On October 17, the feedback was incorporated into SurveyCTO®, which was then completed. The actual survey began on October 18 and lasted until December 11.

Quality control measures

Several measures were undertaken to ensure quality data was collected and well-maintained:

- *Recruitment of qualified supervisors and enumerators*
  The enumerators had reasonable experience in data collection with reputable research organizations. Additionally, the supervisors were well qualified for the work, all having supervised previous surveys.
- *Adequate training*
  The training was scheduled for a total of five days to ensure that the enumerators were fully conversant with the questionnaire and that all arising issues were clarified and questions answered. This also provided enough time to practice pairing tablets for program updates and data transmission.
- *Team composition during fieldwork*
  The fieldwork teams were carefully formed to work with people in the local language and ensure that each team had an adequate number of experienced enumerators.
- *Monitoring and guidance during fieldwork*
  During the fieldwork (particularly the first days), supervisors sat in on the interviews of new enumerators. Any noted mistakes were discussed in meetings held each evening after the fieldwork by each team.
- *Timely data transmission and strict monitoring of uploaded data*
  Data collected during the day was transmitted to the SurveyCTO® server by supervisors every evening. The supervisors also communicated to the KPS lead a summary of the questionnaires and household IDs collected by each team member during that day. Any mistakes noted (for instance duplicate household IDs) were communicated to the teams the same evening through the supervisors.

Apart from the above, we conducted the following: (1) pilot testing of the questionnaire; (2) placing various control systems in the digital tool; (3) supervisors and coordinators accompanying and doing spot checks in the field before data uploads to the server; and 4) GPS location tracking.

3.4 Limitations of data collection and challenges faced

Below, we outline the challenges faced while undertaking the baseline and endline surveys.

Longer time taken in household identification and mobilization

The team first received a support letter from Odisha Livelihood Mission to carry out the baseline survey. A similar letter was received for the endline survey. Household selection began at a slow pace and took longer than planned. The survey team could not locate SHGs in approximately 20–25 villages. Some did not exist, some names were mismatched with the supplied list, and some had already disbanded before our survey.

As a result, a decision was made in consultation with the research team and WASSAN to conduct the survey using other SHGs or villages. Also, due to the incorrect spelling of a few villages, they were challenging to locate. Because the SHGs have been promoted by other local NGOs, the survey team faced difficulty mobilizing some village SHGs and locating respondents, particularly in the Dasamantpur and Koraput blocks.

Challenges in selecting thresher-owning SHGs during the baseline survey
There were some discrepancies between the reported list and the actual situation. There were 4–5 SHGs that were supposed to have threshers but had not yet received them at the time of the survey. Additionally, 4–5 threshers were distributed to producer groups rather than to the intended SHGs in the Lakhmipur block.

Need for SHG/household replacement
In an unusual case among the SHGs chosen for our sample, a men-only SHG was selected in the village Umari but was quickly replaced by a women-only SHG. In addition, achieving the target of sample of 1,660 households became difficult because, in some instances, two members of the same household were members of the same SHG. As only one respondent was selected from a single household, this resulted in a reduction in the sample by 39 households, bringing the total coverage to 1,621. As a result, the survey was expanded to include 39 new respondents from additional villages. (Baipariguda block's Kadalipadar and Pottangi block's Mulapodalguda).

COVID-related challenges
In general, the Koraput district was not significantly affected by COVID-19, and most of our sample areas were remote and very far away from the town. The villagers usually did not care about COVID, and most were not even aware of the pandemic and did not believe in its adverse impact. They treated it as a normal flu and were confident about their ability to cure it with local herbs and herbal medicine (*kadha*). Therefore, there were no restrictions imposed by the communities on the movement of outsiders. Our team, however, took all government-mandated precautions for the prevention of COVID-19 infection, such as regular hand sanitization, wearing of masks, and frequent disinfection of surfaces. We strictly followed social-distancing rules and preferred to conduct interviews in an open or well-ventilated and uncrowded spaces.

Endline attrition
The research team envisioned three possible scenarios that could lead to attrition during the endline survey:

1. The baseline household moved away from the village;
2. The member who answered the household questionnaire in the baseline survey is not available (but the SHG member is available); or
3. The SHG member who answered the baseline women's questionnaire is not available.

The protocol below was adopted to address these scenarios in the field.

SCENARIO A: Baseline household has moved away from the village

Actions to implement according to feasibility in order of preference:

If the household can be located in a nearby area

a) Trace household to their new location and conduct the interview there.

If the household cannot be located

b) Replace household with another from the same village and the same SHG.
c) Replace household with another from the same village and another SHG.
d) Drop household without replacement.

SCENARIO B: The member who answered the household questionnaire in the baseline survey is not available

Actions to implement according to feasibility in order of preference:

a) Return to the household at a later date when the original respondent is available.
b) Have another household member (e.g., SHG member) answer the household questionnaire.

SCENARIO C: The SHG member who answered the women's questionnaire in the baseline survey is not available

Actions to implement according to feasibility in order of preference:

a) Return to the household at a later date when the original respondent is available.
b) Replace the SHG member with another member from the same village and the same SHG.
c) Replace the SHG member with another member from the same village and another SHG.
d) Drop household without replacement.

This protocol was implemented during the endline survey. The realized attrition upon completion of the endline survey is described below. Compared to the baseline sample of 1,679 households, the endline sample was reduced to 1,676 (a reduction of three households).

Overall, 54 respondents from the baseline sample were dropped and replaced by 51 new respondents, while three could not be replaced. Of the 51 new respondents, 41 were replacements from within the same baseline household, while 10 were completely new households (and new respondents) at endline. Of the 41 baseline respondents who were replaced from within the same household at endline, 14 had migrated permanently or were consistently absent during the survey period. A total of 8 women had married and moved out of the baseline households to form their own household, 11 had ceased being members of the SHGs due to old age, and 9 had passed away since the baseline survey.

Among the 10 new households, 2 were replacements for households that had migrated out of the village and could not be tracked. The remaining 8 new households were replacements for households in which the key respondent had passed away following the baseline survey and there was no eligible household member to serve as a replacement.

Overall attrition at the household level was less than 1 per cent (13 out of 1,679), and attrition at the respondent level was 3.2 per cent.

4. Findings

4.1 Intervention implementation fidelity

4.1.1 Internal validity

By offering support and services related to millet processing and value addition on a cluster-level and randomized basis, we had a clear strategy for identifying the effects of our intervention compared to the control group, since the implementation team, WASSAN, being an OMM implementation secretariate, has direct control over who will be offered processing and value-addition services.

In this report, we focus on intention-to-treat (ITT) effects because of the high level of uptake of the intervention among the intended beneficiaries.[3] Attendance records at the training sessions show that the SHG members in Treatment Arms 1 and 2 attended, on average, 4.4 of the first 5 training sessions (the sixth and final training session was offered only to beneficiaries in Treatment Arm 2 as per our experimental design).

Over 90% of the SHG members added three or more training sessions. And fewer than 2% failed to attend any training sessions at all. Even in instances where an SHG member was absent from a training session, at least one individual from the same SHG was in attendance 80-90% of the time: some level of knowledge transmission to absent beneficiaries from group members who were present at the session is plausible. For these reasons, we expect the ITT effect to be close to the average treatment effect. In future analysis, we plan to test this hypothesis by estimating the local average treatment effect as per the procedure described above.

4.1.2 Balance table

We compare the control group with Treatment 1 arm (support and services related to millet processing) and then the control with Treatment 2 arm (support and services related to millet processing and value addition) at baseline, separately, and then compare their means using a two-sample t-test (Table 8–11).

The aim of this exercise is to check for baseline covariate balances between and among the experiment groups to assess whether randomization was effective in delivering comparable groups. We include the key variables that will later be used in impact models either as outcome or control variables. To check the baseline balance, it is important to look at the size of the difference rather than the statistical significance (Imbens and Rubin, 2015).

Imbens and Rubin (2015) propose a normalized differences approach that provides a scale-invariant measure of the size of the difference. We calculate the normalized difference for all our dependent and independent variables (Table 8–11) and find all the differences to be below 0.25, which indicates that we have a good baseline balance for all our variables of interest. This signifies that the treatment assignment was balanced, and therefore, selection bias (common in small samples) was not a concern in our study.

[3] Some households randomly assigned with the processing and value-addition training and support ultimately did not receive them due to their non-attendance. Therefore, in future analysis we plan to estimate local average treatment effects using random assignment to study arms as instrumental variables for participation. In our study context, the local average treatment effect is the effect of services among the sub-population who were offered processing and value-addition services and who ultimately took advantage of them.

Table 8: Baseline balance of covariates

Variable	N	(1) Control mean/SE	N	(2) T arm_1 mean/SE	N	(3) T arm_2 mean/SE	Normalized difference (1)-(2)	Normalized difference (1)-(3)	Normalized difference (2)-(3)
# household members	539	4.750	577	4.633	563	4.780	0.064	-0.016	-0.081
		[0.083]		[0.073]		[0.080]			
# male HH members 14yrs+	539	1.596	577	1.664	563	1.675	-0.073	-0.082	-0.011
		[0.040]		[0.039]		[0.043]			
# male HH members below 14yrs	539	0.690	577	0.594	563	0.652	0.123	0.048	-0.074
		[0.034]		[0.031]		[0.034]			
# female HH members 14yrs+	539	1.770	577	1.747	563	1.821	0.026	-0.057	-0.084
		[0.038]		[0.036]		[0.037]			
# female HH members below 14yrs	539	0.694	577	0.629	563	0.632	0.071	0.070	-0.004
		[0.040]		[0.038]		[0.035]			
# female SHG members	539	1.111	577	1.099	563	1.085	0.038	0.083	0.044
		[0.014]		[0.013]		[0.013]			
Age	539	39.443	577	39.177	563	39.639	0.021	-0.015	-0.037
		[0.559]		[0.501]		[0.534]			
Years of education	539	1.759	577	2.289	563	1.943	-0.146	-0.052	0.091
		[0.143]		[0.162]		[0.156]			
Currently married	539	0.826	577	0.846	563	0.805	-0.054	0.054	0.108
		[0.016]		[0.015]		[0.017]			
F-test of joint significance (F-stat)							1.798*	1.255	1.399
F-test, number of observations							1,116	1,102	1,140

*Note: The table displays the differences in the means of covariates across treatment groups. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level, respectively.*

Table 9: Baseline balance of primary outcomes

Variable	N	(1) Control mean/SE	N	(2) T arm_1 mean/SE	N	(3) T arm_2 mean/SE	Normalized difference (1)-(2)	Normalized difference (1)-(3)	Normalized difference (2)-(3)
Total household income	538	50,488.514	577	52,059.696	563	47,359.030	-0.026	0.059	0.086
		[2,587.925]		[2,592.787]		[1,929.587]			
Woman's enterprise income	538	530.260	577	207.972	563	632.877	0.059	-0.013	-0.059
		[282.575]		[176.069]		[390.283]			
Total invested in business	538	3,029.911	577	1,723.050	563	1,651.332	0.081	0.103	0.005
		[666.843]		[689.836]		[466.560]			
Household dietary diversity score	539	9.414	577	9.386	563	9.483	0.018	-0.047	-0.063
		[0.064]		[0.066]		[0.064]			
Access to productive assets	539	1.343	577	1.241	563	1.210	0.070	0.090	0.022
		[0.064]		[0.059]		[0.062]			
Input in sale of assets	539	1.265	577	1.057	563	1.140	0.175	0.102	-0.070
		[0.053]		[0.048]		[0.052]			
Input in purchase of assets	539	1.191	577	1.055	563	1.101	0.116	0.076	-0.039
		[0.051]		[0.048]		[0.050]			
# of groups with woman in lead role	539	0.215	577	0.189	563	0.187	0.064	0.070	0.006
		[0.018]		[0.017]		[0.017]			
Time (min) on own business	539	65.176	577	65.043	563	69.139	0.001	-0.032	-0.032
		[5.185]		[5.205]		[5.416]			
Time (min) on farming/livestock	539	187.430	577	203.995	563	185.355	-0.092	0.012	0.101
		[7.626]		[7.659]		[7.728]			
Time (min) on childcare	539	31.809	577	31.898	563	38.472	-0.001	-0.100	-0.096
		[2.553]		[2.619]		[3.096]			
Time (min) on sick/elderly care	539	1.558	577	2.210	563	1.066	-0.050	0.052	0.096
		[0.458]		[0.614]		[0.345]			
Time on childcare + others	539	108.006	577	126.473	563	108.357	-0.081	-0.002	0.078
		[9.198]		[10.071]		[9.371]			
Prop. of activ. woman has income control over	539	0.281	577	0.263	562	0.281	0.094	0.000	-0.093
		[0.008]		[0.008]		[0.008]			
F-test of joint significance (F-stat)							1.442	0.950	1.586*
F-test, number of observations							1,115	1,100	1,139

*Note: The table displays the differences in the means of covariates across treatment groups. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level, respectively.*

Table 10: Baseline balance of secondary outcomes

Variable	N	(1) Control mean/SE	N	(2) T arm_1 mean/SE	N	(3) T arm_2 mean/SE	Normalized difference (1)-(2)	Normalized difference (1)-(3)	Normalized difference (2)-(3)
Value of food consumption	539	1,106.488	577	1,062.088	563	1,135.659	0.079	-0.046	-0.119
		[25.099]		[22.732]		[28.655]			
Food security index	539	1.393	577	1.085	563	1.673	0.124	-0.099	-0.216
		[0.112]		[0.098]		[0.128]			
Food worry pre. 7 days	539	0.314	577	0.241	563	0.336	0.162	-0.047	-0.209
		[0.020]		[0.018]		[0.020]			
Life satisfaction today	539	0.727	577	0.769	563	0.739	-0.097	-0.026	0.071
		[0.019]		[0.018]		[0.019]			
Life satisfaction in 5 years	539	0.738	577	0.787	563	0.753	-0.114	-0.034	0.080
		[0.019]		[0.017]		[0.018]			
SHG decisions–- members participate	539	0.686	577	0.716	563	0.725	-0.064	-0.084	-0.020
		[0.020]		[0.019]		[0.019]			
SHG purchases–- members participate	539	0.536	577	0.525	563	0.545	0.022	-0.018	-0.040
		[0.022]		[0.021]		[0.021]			
SHG # members	538	10.636	575	10.805	562	10.630	-0.119	0.004	0.120
		[0.061]		[0.059]		[0.063]			
Volume of loans from SHG	539	3,132.401	577	4,278.023	563	2,583.798	-0.089	0.051	0.186
		[614.698]		[478.799]		[233.772]			
Volume of bank loans received	539	1,963.505	577	693.241	563	222.025	0.131	0.189	0.106
		[549.421]		[228.512]		[129.391]			
Prop. child. in age-appropriate education	336	0.836	301	0.874	347	0.884	-0.122	-0.158	-0.035
		[0.018]		[0.017]		[0.015]			
F-test of joint significance (F-stat)							1.408	1.519	1.528
F-test, number of observations							635	681	646

*Note: The table displays the differences in the means of covariates across treatment groups. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level, respectively.*

Table 11: Baseline balance of enterprise outcomes

Variable	N	(1) Control mean/SE	N	(2) T arm_1 mean/SE	N	(3) T arm_2 mean/SE	Normalized difference (1)-(2)	Normalized difference (1)-(3)	Normalized difference (2)-(3)
Number of HH enterprises	539	0.161	577	0.123	563	0.119	0.097	0.115	0.011
		[0.017]		[0.016]		[0.015]			
# of female-owned enterprises	539	0.058	577	0.000	563	0.023	0.350	0.176	-0.217
		[0.010]		[0.000]		[0.006]			
Loans from banks	539	46.382	577	55.459	563	135.290	-0.009	-0.078	-0.073
		[46.382]		[41.855]		[50.053]			
Loans from informal sources	539	0.000	577	155.979	563	5.329	-0.078	-0.059	0.076
		[0.000]		[116.179]		[5.329]			
Sales revenue from HH enterprises	539	16,754.980	577	24,127.903	563	1,3514.742	-0.084	0.051	0.122
		[2,714.819]		[4,383.894]		[2,654.826]			
Profits from HH enterprises	539	7,165.755	577	8,959.099	563	5,000.178	-0.048	0.075	0.120
		[1,467.521]		[1,665.277]		[980.583]			
Business startup capital	539	7,052.861	577	6,068.631	563	3,417.346	0.027	0.109	0.098
		[1,796.787]		[1,290.245]		[934.273]			
F-test of joint significance (F-stat)							5.755***	2.313**	2.968***
F-test, number of observations							1,116	1,102	1,140

*Note: The table displays the differences in the means of covariates across treatment groups. ***, **, and * indicate significance at the 1%, 5%, and 10% critical level, respectively.*

4.1.3 Spillover

Since our unit of randomization is a cluster, we make sure a whole village is either the control or one of the treatments. Administering the randomization process in this way helps us to prevent any spillover effects. Hence, the potential outcome of one unit should not be affected by the assignment of the other units, and therefore the stable unit treatment value assumption (Rubin 1978, 1980) is not violated, making our inference internally valid.

4.1.4 Implications for ex-post power calculation

Our ex-post power calculation (Table 2) affirms that we have a large enough sample size to achieve a power of 0.8 for each outcome variable.

4.1.5 External validity

One of the greatest threats to the external validity of randomized evaluations is the fact that they are frequently only implemented for a relatively short period of time, and within a relatively limited geographic area; therefore, extrapolating longer-term or more representative impacts should always be done cautiously.

These same considerations hold with regard to our evaluation, though we implement some safeguards in an attempt to ameliorate such threats. For example, it usually takes an SHG member some time to learn about various aspects of millet processing and value addition using advanced machinery, although they have been carrying out millet processing in a traditional way. The real value in the provision of millet processing occurs when it improves business investment and income generation. The impact of such an enterprise on increasing women's decision-making authority within the household and on household welfare (e.g. nutrition, health, and education of children) may take some time.

We also accounted for initial household conditions in the effects of the millet processing and value-addition enterprise, to improve external validity. Our pilot study sample may be representative of a broader context beyond Koraput, particularly in semi-arid regions of Asia and Africa where millet cultivation is widespread. The innovative collective-enterprise training developed under this project has the potential for implementation in these diverse contexts. Further research could test whether similar results can be achieved in these different settings, thus expanding the applicability and impact of our findings.

4.2 Impact analysis

4.2.1 Descriptive statistics

Summary statistics of socioeconomic and demographic characteristics and the primary, secondary, and enterprise outcomes of the sample are provided in Table 12. In our sample of 1,676, the average household size is about five, with an average of one female SHG member in a household. The majority (84%) of household heads are male with an average age of 45.5 years, and more than half (53%) have no education.

Only 16% of households in the sample are headed by a female. The average age of individual female SHG respondents is about 41 years, and 82% of them are currently married. The majority (71%) of them have no education, while 16% have primary education and 12% have secondary education.

A summary of the primary outcomes shows an average annual household income (calculated as the value of harvest minus the cost of inputs, plus NREGA wages, other wage earnings, earnings from other sources, and profits from enterprises) of about INR 102,000. The average income from female-owned enterprises (across all enterprises) is just over INR 1,000.[4]

To construct the household dietary diversity score, we asked respondents if, in the past seven days, they had consumed a host of food items, which were categorized into 12 discrete food groups. We then created binary response variables corresponding with these food groups, whose values were one if at least one item in the group was consumed at least once in the past seven days, and zero otherwise. We then summed up the food groups for each household, which gave us their score on a 12-point scale. The higher the score, the more diverse the household's diet (therefore, positive effects were desired). At endline, the average household dietary diversity score is 9.3.

On average, 18% of women reported having a leadership role in at least one SHG group. In terms of productive activities, the sampled women reported having control over the use of income in just 29% of their activities. This is equivalent to an average of 2 out of 9 productive activities. Although the number of productive assets that women in our sample have access to is one on average, 85 per cent of respondents reported having input in decisions regarding the sale or purchase of household productive assets.

Generally, 34% have sole ownership of at least one productive asset. Average household investments in own business stands at about INR 9,000. Women's participation in decision-making is measured by their access to productive resources such as agricultural land, livestock, etc., as well as their level of control over the sale and/or purchase of productive resources. The women in our sample reported having access to an average of 1.31 different productive resources and have control over the sale and purchase, on average, of 1.55 productive resources.

Regarding the use of their time, we asked the women how many minutes they spent on a variety of activities within and outside the household in the past 24 hours. On average, each woman spent 100 minutes running her own business, 139 minutes farming or taking care of livestock, about 31 minutes on childcare and/or caring for an elderly household member, about 330 minutes on domestic chores, and about 838 minutes on personal care.

A look at the descriptive statistics for the secondary outcomes reveals that respondents on average spent roughly INR 1,034 on food consumption in the seven days prior to the survey. About 30 per cent reported that they worried about not having enough food in the same period. We constructed a food security index by asking households whether they had gone without food or had less food within the past seven days. The index shows that an average household went without, or had less food, for 0.52 days.

In terms of the subjective welfare index, 87% of respondents reported being happy with their lives currently, and an equal number expected to be happy with their lives in five years' time. Regarding membership and social capital, 81% reported that they participate

[4] These figures differ significantly from their counterparts in the baseline report (see E^{2}IMPART baseline report).

in group decision-making, and about 61% reported that they can participate in decisions regarding purchases in the group. On average, 54% of respondents had taken a loan from any source in the 12 months prior to the survey. While the average loan amount from an SHG stood at INR 10,567, the average loan from banks is INR 890. A total of 83% of children in sampled households had completed their age-appropriate class.

Turning to the household enterprise outcomes, about 30% of households run enterprises, either on their own or in partnership with others (about 26% of households in the sample run exactly one enterprise, while 3% of households run two or more; this yields an average of 0.33 enterprises per household). In addition, 23% of households have a female-owned enterprise.

A closer look at ownership type reveals that 69% of households run enterprises that are SHG-based, 7% are solely female-owned, and 24% are owned solely by a male household member. The average sales revenue and profits from enterprises are slightly over INR 39,000 and INR 13,427, respectively, for the last 12 months. On average, household business start-up capital is about INR 10,600. Female-owned enterprises have on average, an outstanding loan of INR 275 from SHGs.

Table 12: Summary statistics

Panel A: Summary statistics - household demographic composition

Variable	Obs.	Mean	Std. dev.	Min	Max
# household members	1,666	4.72	1.86	1	16
# male HH members 14yrs+	1,676	1.68	0.98	0	6
# male HH members below 14yrs	1,676	0.58	0.76	0	4
# female HH members 14yrs+	1,676	1.82	0.92	0	6
# female HH members below 14yrs	1,676	0.59	0.85	0	5
# female SHG members	1,676	1.05	0.34	0	3

Panel B: Summary statistics - household head and asset ownership

Variable	Obs.	Mean	Std. dev.	Min	Max
Age of HH head	1,621	45.62	12.01	19	83
Female-headed household	1,621	0.16	0.37	0	1
HH head education level	.	.	.	.	.
No education	1,620	0.53	0.5	0	1
Primary education	1,620	0.24	0.43	0	1
Secondary education	1,620	0.21	0.41	0	1
Higher education	1,620	0.02	0.14	0	1
HH head marital status	.	.	.	.	.
Never married	1,621	0.02	0.13	0	1
Currently married	1,621	0.86	0.35	0	1
Separated/divorced	1,621	0.01	0.12	0	1
Widowed	1,621	0.11	0.32	0	1
Household owns land	1,676	0.92	0.27	0	1
Land area (acres)	1,676	2.6	3.85	0	83

Panel C: Summary statistics - female respondent SHG member

Variable	Obs.	Mean	Std. dev.	Min	Max
Age of SHG member	1,667	41.32	12.51	18	83
Educational level	.	.	.	.	.
No education	1,667	0.71	0.45	0	1
Primary education	1,667	0.16	0.36	0	1
Secondary education	1,667	0.12	0.32	0	1
Higher education	1,667	0.01	0.11	0	1
Marital status	.	.	.	.	.
Never married	1,667	0.04	0.2	0	1
Currently married	1,667	0.82	0.39	0	1
Separated/divorced	1,667	0.02	0.14	0	1
Widowed	1,667	0.12	0.33	0	1

Panel D: Summary statistics - primary outcomes

Variable	Obs.	Mean	Std. dev.	Min	Max
Total household income (INR)	1,676	104,213.96	160,566.94	-27,700	3,042,400
Woman's enterprise income (INR)	1,676	1,090.17	101,70.12	0	360,000
Woman's enterprise income (INR)*	497	3,676.3	18,432.65	0	360,000
Total invested in business	1,676	9,029	44,789.07	0	541,000
Household dietary diversity score	1,676	9.3	1.32	6	12
Access to productive assets	1,676	1.31	1.41	0	6
Input in sale of assets	1,676	1.55	1.38	0	5
Input in purchase of assets	1,676	1.53	1.38	0	5
# groups woman has lead role	1,632	0.18	0.39	0	2
Owns at least one asset solely	1,676	0.34	0.47	0	1
Input in sale decision of HH ass	1,676	0.82	0.39	0	1
Input in purchase decision of HH	1,676	0.82	0.38	0	1
# of productive activities over which indiv. has income control	1,676	2.32	1.58	0	9
Time (min) on own business	1,676	100.13	160.37	0	690
Time (min) on farming/livestock	1,676	139.12	167.11	0	570
Time (min) on child/elderly care	1,676	31.88	65.03	0	480
Time (min) on domestic chores	1,676	330.41	129.14	0	840
Time (min) on personal activities	1,676	838.29	145.66	480	1,440
Time on childcare + other activities	1,676	43.03	120.85	0	840
Prop. activities over which woman has income control	1,675	0.29	0.18	0	1

*Note: * This is reported for a sub-sample of households with at least one enterprise.*

Panel E: Summary statistics - secondary outcomes

Variable	Obs.	Mean	Std. dev.	Min	Max
Value of food consumption	1,676	1,034.45	1,382.07	130.08	50,640.31
Alt. value of food consumption	1,676	1,163.62	1,344.34	145.7	50,820.33
Food security index	1,676	0.52	1.89	0	23
PCA - food security index	1,676	0	1	-0.28	13.44
Food worry pre. 7 days	1,676	0.12	0.32	0	1
Life satisfaction today	1,676	0.87	0.34	0	1
Life satisfaction in 5 years	1,676	0.87	0.33	0	1
SHG decisions - members participate	1,630	0.81	0.39	0	1

Variable	Obs.	Mean	Std. dev.	Min	Max
SHG purchases - members participate	1,630	0.61	0.49	0	1
SHG # members	1,628	10.66	1.55	6	18
Loan taken by female from any source	1,676	0.54	0.5	0	1
Volume of loans from SHG	1,676	10,567.22	19,204.51	0	300,000
Volume of bank loans received	1,676	890.81	6,789.94	0	90,000
Prop. children in age-appropriate education	963	0.83	0.35	0	3

Note: PCA = principal component analysis. The food security index uses values between 0–56, with higher values corresponding to higher food insecurity.

Panel F: Summary statistics - enterprise outcomes

Variable	Obs.	Mean	Std. dev.	Min	Max
# of HH enterprises	1,676	.33	.56	0	4
# of female owned enterprises	1,676	.23	.42	0	1
HH owns an enterprise	1,676	.3	.46	0	1
Enterprise ownership type	.	.	.	.	.
SHG-based	497	.69	.46	0	1
Solely female-owned	497	.07	.26	0	1
Solely male-owned	497	.24	.42	0	1
Loans to woman from informal source	1,676	2.98	122.13	0	5,000
Loans to woman from SHG	1,676	275.46	5,992.08	0	180,000
Sales revenue from HH enterprise	1,676	39,279.13	204,694.22	0	5,400,000
Sales revenue – sub-sample*	497	132,458.41	359,344.93	0	5,400,000
Profit from household enterprise – sub-sample*	497	45,279.49	118,768.11	0	1,500,000
Business startup capital – sub-sample*	497	35,783.42	78,984.98	0	700,000
Business startup capital	1,676	10,611.19	45,985.27	0	700,000

Source: Endline survey data.
*Note: Business loans are reported only for enterprises in which the female respondent is an owner or partner. * These are reported for a sub-sample of households with at least one enterprise.*

4.2.2 ITT effects

Empirical strategy

The randomization allows for a simple estimation strategy to estimate the treatment effects, as it ensures that without the intervention, the expected outcomes are statistically not significantly different between treatment and control villages. We estimate the ITT effect, which is the average effect of the intervention for all households in treatment villages, compared to all households in control villages, irrespective of actual household participation in the intervention. The ITT effect for household i in village (cluster) j and block r is as follows:

$$y_{ijr} = \alpha + \tau_{ITT} T_i + \sigma_r + \varepsilon_{ijr} \qquad (1)$$

where y_{ijr} is the observed outcome variables (entrepreneurial activities, household welfare, women's empowerment), T_i is a household-level treatment status, = 1 if the household in a village randomized to receive support for millet processing, = 2 if the household in a village randomized to receive support for millet processing and value addition, and = 0 if the household in a village receives no treatment; σ_r is the block-level

fixed effects to account for block-level stratification in the experimental design (account for variation across 10 blocks in the sample);[5] and ε_{ijr} is the idiosyncratic error term clustered at the village level.[6]

The coefficient τ_{ITT} captures the average treatment effect of being randomly offered the intervention, which is the ITT parameter of interest. To account for any imbalance in baseline characteristics and improve precision in the estimation, we specify the regression by adding a vector of baseline household covariates. Hence, the covariate-adjusted ITT estimation equation becomes:

$$y_{ijr} = \alpha + \tau_{ITT} T_i + \sigma_r + \beta X_{ijr} + \varepsilon_{ijr} \qquad (2)$$

where X_{ijr} is a vector of household characteristics such as age, education level of the household head, marital status of the household head, sex of household head, female-headed household, total number of male and female members above and below 14 years of age, and number of female SHG members in the household. Coefficient β is a vector of parameters associated with household characteristics. We also specify the ANCOVA estimate of the treatment effect as presented by McKenzie (2012) and define it as:

$$y_{ijr} = \alpha + \tau_{ITT} T_i + \sigma_r + \beta X_{ijr} + \gamma y_{ijr,PRE} + \varepsilon_{ijr} \qquad (3)$$

where $y_{ijr,PRE}$ is the value of the outcome variable from baseline (pre-treatment). Because they rely on the full sample of data and control for baseline outcomes, the ANCOVA estimates with covariates are our preferred estimates. We estimate (1)–(3) using ordinary least squares for continuous outcomes, and linear probability models for categorical outcomes, where standard errors are adjusted for intra-cluster correlation at the unit of randomization—the village (Abadie et al. 2017).

Empirical results

The estimated results based on Equation (3) are reported in Tables 13–16. For ease of reporting, the tables do not include the estimated coefficients of the control variables.

In Panel A of Table 13, the outcomes relate to the inverse hyperbolic sine of household income, female enterprise income, and business investments in female enterprises. The estimated effect of both treatments on household income is negative, albeit statistically

[5] A "block" (also known as a community development block) is an administrative division situated between the *tehsil/taluk* and the village level. Each block typically consists of several villages and *panchayats* (village councils). See the Indian Ministry of Rural Development for further information about the administrative structure, including the role of blocks: https://rural.gov.in/en.

[6] In Cluster Randomized Trial (CRT), the unit of observation (individual household) is different from the unit of randomization (village/cluster). The main feature of CRT is that the observations of individual households within a cluster are usually correlated. If we ignore this clustering in analysis and use the standard method of analysis, we get p-values that are too small and end up wrongly identifying an effect. There are three main methods to account for correlated data in CRT: cluster-level analysis (by calculating a summary measure of the outcome of interest for each cluster); using a random-effect model (by assuming that the variation of cluster-level means follows a normal distribution); and using a generalized estimation equation (where standard errors are adjusted for the intra-cluster correlation in the data) (Hayes and Moulton 2017). We take the latter approach in our analysis.

insignificant. Treatment 1 also has negative, statistically insignificant effects on female enterprise income and business investments. By contrast, Treatment 2 has an estimated positive and large effect on female enterprise income and business investments. The estimates imply increases in female enterprise income and business investments to, respectively, six-fold and 54-fold the corresponding values in the control arms.

In Panel B of Table 13, we report estimates on a number of outcomes related to the SHG member's economic empowerment: an individual empowerment score (Column 1), a self-efficacy index (Column 2), the number of different types of production-related decisions made for the enterprise (Column 3), the number of different household productive activities for which the individual controls income (Column 4), and the number of hours worked in a typical day (Column 5).

For neither treatment do we see a statistically significant effect on the empowerment score (and the point estimates are close to zero). In the case of Treatment 1, the estimates imply an increase in self-efficacy and a reduction in working hours, with no effect on entrepreneurial decision-making and income control. In the case of Treatment 2, the estimates imply an increase in entrepreneurial decision-making and income control, as well as a reduction in working hours. There is also some evidence that Treatment 2 increased self-efficacy (sizeable and positive point estimate, albeit statistically insignificant at conventional levels).

In Panel C of Table 13, the outcomes relate to the female SHG member's ownership and control of productive assets within the household: namely, the number of productive assets over which she has sole or joint ownership (Column 1), input in decisions regarding sales/rentals/mortgages (Column 2), and input in decisions regarding purchases (Column 3). The estimated effects for all three outcomes and across both treatment arms are negative and, in most instances, statistically significant. In other words, the intervention appears to have *reduced* the SHG member's control over productive assets and sale and purchase decisions on productive assets within the household.

In Panel D of Table 13, the outcomes relate to the SHG member's time allocation during the 24 hours preceding the survey (more precisely, from 4am on the day preceding the survey to 3:59am on the day of the survey). The dependent variables in Columns (1)–(5) describe minutes spent engaged in five different types of activities that are mutually exclusive and exhaustive. In most instances, the estimated treatment effects are small in magnitude (and statistically insignificant).

However, we find a reduction in time spent on farm work by an average of about 30 minutes in both treatment arms, and an increase in time spent in self-care and social activities by about 24 minutes for Treatment 1 and about 28 minutes for Treatment 2. In other words, both treatments resulted in a shift in time allocation from farm work towards leisure activities and personal care by the SHG members, with no significant changes in time spent on enterprise activities, household chores, and caring for others.

A possible reason for these changes in time allocation is that the training helped SHG members to strengthen their bargaining power within the household, and thus negotiate more time for leisure and personal care and reduce their labor input in household activities (that, potentially, do not generate income for themselves).

Table 13: Average treatment effects on primary outcomes

Panel A: Income and investments

	(1) tot_income	(2) fem_entrp_inc	(3) biz_investm
Treatment arm_1	-0.231	-0.293	-0.128
	(0.1945)	(0.4621)	(0.4752)
Treatment arm_2	-0.116	1.776**	3.955**
	(0.1571)	(0.6195)	(0.6999)
Constant	10.503**	-0.095	-0.565
	(0.8901)	(1.1087)	(1.4194)
Observations	1,662	1,662	1,662
Adjusted R^2	0.004	0.137	0.284
T1 = T2	0.525	0.000	0.000

Notes: IHS = inverse hyperbolic sine; T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - IHS of total household income
Model 2 - IHS of income from female-owned enterprise
Model 3 - IHS of total investments in female-owned enterprise
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel B: Empowerment outcomes

	(1) emp_score	(2) self_eff	(3) dec_entr	(4) inc_contrl	(5) work_bal
Treatment arm_1	0.010	0.193+	-0.070	-0.091	-0.362+
	(0.0129)	(0.1139)	(0.1139)	(0.0826)	(0.1919)
Treatment arm_2	0.012	0.160	1.192**	0.578**	-0.513*
	(0.0117)	(0.1106)	(0.1999)	(0.1234)	(0.1982)
Constant	0.295**	14.087**	-0.297	0.030	11.334**
	(0.0514)	(0.8695)	(0.4741)	(0.3450)	(0.9343)
Observations	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.044	0.025	0.144	0.140	0.153
T1 = T2	0.875	0.775	0.000	0.000	0.441

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Individual empowerment score
Model 2 - Self-efficacy score; higher values indicate greater confidence in own capabilities
Model 3 - Number of enterprise productive decisions made
Model 4 - Number of productive activities in which the individual has control over the use of income (makes input to at least a medium extent)
Model 5 - Number of hours worked in a typical day

Panel C: Asset ownership and control

	(1) assets_owned	(2) sale_input	(3) purchase_input
Treatment arm_1	-0.276**	-0.275**	-0.213*
	(0.0986)	(0.1042)	(0.1023)
Treatment arm_2	-0.162	-0.269**	-0.193+
	(0.1083)	(0.1017)	(0.0992)

	(1) assets_owned	(2) sale_input	(3) purchase_input
Constant	0.158	0.737	0.423
	(0.3923)	(0.4831)	(0.4764)
Observations	1,662	1,662	1,662
Adjusted R^2	0.058	0.040	0.037
T1 = T2	0.288	0.956	0.844

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
Standard errors in parentheses. $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01
Model 1 - Number of productive assets respondent owns solely or jointly
Model 2 - Number of productive assets for which respondent makes input in sale decisions
Model 3 - Number of productive assets for which respondent makes input in purchase decisions
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel D: Time allocation (24 hours preceding the survey)

	(1) hrs_ownbiz	(2) hrs_farming	(3) hrs_caring	(4) hrs_chores	(5) selfcare
Treatment arm_1	-0.813	-31.548**	5.144	0.991	24.012*
	(14.1661)	(11.5939)	(3.3199)	(9.9948)	(11.0475)
Treatment arm_2	6.663	-29.496*	2.489	-9.160	28.124**
	(13.8617)	(12.7868)	(3.2163)	(8.8871)	(10.6671)
Constant	116.457*	9.460	110.806**	321.041**	742.514**
	(46.3372)	(41.9336)	(16.5533)	(35.3696)	(54.3771)
Observations	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.039	0.181	0.217	0.047	0.132
T1 = T2	0.593	0.871	0.397	0.231	0.706

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
Standard errors in parentheses. $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01
Model 1 - Hours spent on own enterprise
Model 2 - Hours spent on farming activities
Model 3 - Hours spent on child/elderly care
Model 4 - Hours spent on domestic chores
Model 5 - Hours spent on self-care/social activities
Estimates include controls for baseline characteristics and baseline outcomes.

Next, we turn to the estimated effects on secondary outcomes reported in Table 14. In Panel A, we report estimates for outcomes related to food consumption, food security and dietary diversity. The four outcome measures we consider are as follows: (1) a log of the value of food consumption during the seven days preceding the survey; (2) a food security index based on the first principal component of responses to eight questions on food security (see questions I2A–I2H in Section I of the baseline and endline questionnaires); (3) an indicator for whether the household had food worries during the preceding seven days (question 1 in Section I); and (4) a household dietary diversity score (the number of different food groups, out of 12, that the household has consumed during a recall period of seven days) (Sibhatu et al. 2015).

We obtain a precisely estimated, near zero effect on food consumption. We also find positive estimated effects of both treatments on the food security index (higher values indicate greater *insecurity*) and food worry; however, the magnitudes are small and

statistically insignificant. By contrast, we obtain an estimated *increase* in dietary diversity across both arms, in the range of 0.18–0.20 food groups. In other words, while the treatments, on average, did not translate into any changes in food consumption, we found evidence that they led to a small improvement in household dietary diversity.

In Panel B, we report estimates for four other secondary outcomes: (1) the SHG member's self-reported life satisfaction; (2) the proportion of children in the household aged 7–16 in an age-appropriate school year; (3) whether, according to the respondent, SHG members are consulted when the group makes decisions; and (4) the number of members in the SHG. We obtained near-zero, statistically insignificant effects of the two treatments on all these outcomes.

In Panel C, we report estimates on borrowing by the SHG member, including: (1) whether she took any loans from any source during the preceding 12 months; (2) a log of total loan volume from the SHG; and (3) a log of total loan volume from commercial banks. We found no effect on the likelihood of taking out a loan, or the volume of SHG loans for either treatment. However, there is a positive and statistically significant effect on bank loans for both treatments: the estimates imply about a 17.6 per cent increase in the case of Treatment 1, and a 24.5 per cent increase in the case of Treatment 2.

Table 14: Average treatment effects on secondary outcomes

Panel A: Food security and dietary diversity

	(1) food_consumed	(2) fs_indx_pca	(4) food_worry	(5) hdds
Treatment arm_1	0.009	0.108	0.024	0.198*
	(0.0312)	(0.0821)	(0.0199)	(0.0945)
Treatment arm_2	-0.004	0.072	0.024	0.176+
	(0.0341)	(0.0548)	(0.0189)	(0.0993)
Constant	4.917**	0.295	0.208*	6.689**
	(0.2157)	(0.3474)	(0.1004)	(0.4488)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.313	0.081	0.064	0.142
T1 = T2	0.670	0.638	0.995	0.822

Notes: PCA = principal component analysis; T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Log (value) of food consumption
Model 2 - Food security index - using PCA. Higher values indicate greater food insecurity
Model 4 - Food worry in last seven days
Model 5 - Household dietary diversity score
Estimates include village fixed effect, controls for baseline characteristics, and baseline outcomes.

Panel B: Life satisfaction, education, SHG decision-making and size

	(1) life_satis	(2) age_approp	(3) shg_dec	(4) shg_size
Treatment arm_1	0.008	-0.004	0.024	0.049
	(0.0158)	(0.0314)	(0.0284)	(0.1441)
Treatment arm_2	-0.006	-0.021	-0.008	-0.119
	(0.0169)	(0.0289)	(0.0275)	(0.1389)

	(1) life_satis	(2) age_approp	(3) shg_dec	(4) shg_size
Constant	0.914**	0.427**	0.459**	0.948
	(0.0857)	(0.1547)	(0.1279)	(0.8795)
Observations	1,662	855	1,616	1,610
Adjusted R^2	0.027	0.180	0.003	0.779
T1 = T2	0.370	0.549	0.181	0.217

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Woman is satisfied with life today
Model 2 - Proportion of children aged 7–16 in age-appropriate education
Model 3 - Members are consulted in SHG decisions
Model 4 - Number of SHG members
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel C: Loans

	(1) anyloan	(2) shg_loan	(3) bank_loan
Treatment arm_1	0.052	0.251	0.162*
	(0.0741)	(0.7592)	(0.0792)
Treatment arm_2	-0.016	-0.414	0.219**
	(0.0669)	(0.6939)	(0.0818)
Constant	0.408+	4.208+	-0.121
	(0.2093)	(2.1298)	(0.5767)
Observations	1,662	1,662	1,662
Adjusted R^2	0.130	0.116	0.015
T1 = T2	0.350	0.367	0.564

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Woman received any loan
Model 2 - Log (volume) of SHG loan received
Model 3 - Log (volume) of bank loan received
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

In Table 15, we report estimates for outcomes related to entrepreneurial activities within the household, including: (1) number of household enterprises; (2) number of household enterprises owned by female members; (3) log of total startup capital in household enterprises; (4) log of revenues from household enterprises during the previous 12 months; and (5) log of enterprise profits during the previous 12 months.

The estimated treatment effects indicate a sharp difference in entrepreneurial activities between the two treatment arms. Specifically, Treatment 1 has a near-zero effect on the number of household and female-owned enterprises. The estimated effects of Treatment 1 on startup capital, revenues, and profits are positive and large in magnitude (30–40 percentage points) but statistically insignificant.

By contrast, according to our estimates, Treatment 2 increased the number of household enterprises by 0.54, and the number of female enterprises by 0.487, this is equivalent to roughly an additional enterprise in every other household compared to the control arm. Furthermore, the estimates indicate that enterprise startup capital, revenues and profits in the arm increase to 63 times, 67 times, and 16 times, respectively, of equivalent households in the control arm.

Table 15: Enterprise outcomes

	(1) num_entrp	(2) fem_entpr	(3) entr_startup	(4) entr_rev	(5) entrp_profit
Treatment arm_1	0.052	-0.008	0.314	0.324	0.377
	(0.0582)	(0.0473)	(0.4584)	(0.5698)	(0.5122)
Treatment arm_2	0.540**	0.487**	4.145**	4.203**	2.789**
	(0.0819)	(0.0767)	(0.6990)	(0.7757)	(0.6888)
Constant	-0.323+	-0.063	-2.259	-2.200	-2.129
	(0.1778)	(0.1388)	(1.3920)	(1.5613)	(1.4932)
Observations	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.338	0.394	0.327	0.321	0.264
T1 = T2	0.000	0.000	0.000	0.000	0.000

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Number of household enterprises
Model 2 - Number of female-owned enterprises
Model 3 - Log enterprise start-up capital
Model 4 - Log enterprise revenue
Model 5 - Log enterprise profits
Estimates include village fixed effect, and controls for baseline characteristics and baseline outcomes.

In Table 16, we report estimates for outcomes related to social capital within the SHG, based on responses in the trust/investment game implemented at endline, with regard to the amount shared by Player 1 (Column 1), an indicator for whether Player 1 shared 50% or more of the initial pot (Column 2), the return on the initial investment by Player 1 (Column 3), and the inverse hyperbolic sine of the return on the initial investment (Column 4). For both treatments, we obtained small and statistically insignificant effects on the first two outcomes, and negative and statistically insignificant effects on the latter two outcomes.

Thus, the estimates imply that, on average, the intervention had no effect on social capital within the SHGs, as measured by behavior within the trust/investment game. However, we will see in the next section that these null effects mask heterogeneity across different types of SHGs.

Table 16: Social capital outcomes

	(1) shared_amt	(2) shared 50% +	(3) return_self	(4) ihs_return
Treatment arm_1	0.463	0.017	-0.622	-0.362
	(1.1100)	(0.0342)	(1.2264)	(0.2496)
Treatment arm_2	0.579	0.011	-0.619	-0.433+
	(1.0499)	(0.0320)	(0.9952)	(0.2433)
Constant	44.770**	0.703**	10.120**	2.746**
	(5.8954)	(0.1601)	(2.9484)	(0.7621)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.020	0.009	0.037	0.030
T1 = T2	0.908	0.853	0.998	0.784

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Amount offered in trust game

Model 2 - Offered 50% or more
Model 3 - Return on investment in trust game
Model 4 - Inverse hyperbolic sine of return
Estimates include controls for baseline characteristics.

4.2.3 Heterogeneous treatment effects

Next, we investigate heterogeneous treatment effects along two dimensions: (1) whether the SHG was three years of age or older at the start of the intervention; and (2) whether the SHG owned a thresher. For this purpose, we introduce an interaction term to Equation (3), by interacting the treatment status variables with the relevant SHG characteristic. The estimates based on this alternative specification are reported in Tables 17–20.

Table 17, Panel A shows that there is considerable heterogeneity in impacts on incomes and business investments by the age of the SHG. Whereas Table 13, Panel A shows a near-zero average treatment effect, the alternative specification indicates that younger SHGs (below three years of age) experienced a rise in total household income if assigned to Treatment arm 1, and a drop in household income if assigned to Treatment arm 2. Older SHGs did not experience a change in income.

There is also some evidence that younger SHGs assigned to Treatment arm 1 experienced an increase in female enterprise income and in business investments: the coefficients are positive and sizeable, albeit statistically insignificant. However, Treatment arm 2 was more effective in improving female enterprise income and business investments among older SHGs. We also find some evidence that both treatments were more effective in improving female enterprise income and business investments among SHGs that owned a thresher; the interaction terms are positive and large, although statistically insignificant in some instances.

Table 17, Panel B provides evidence that the intervention led to improved control over productive assets among women who belonged to younger SHGs, while the loss of control is concentrated among women in SHGs that lacked a thresher.

Table 17, Panel C shows considerable heterogeneity in the treatment effects on time allocation. The estimates indicate that women in younger SHGs reduced their time spent on farm work and providing care to increase their time spent on household chores. By contrast, women in older SHGs reduced their time spent doing household chores and increased their time spent providing care. We also found that the increase in time spent in self-care is concentrated among women in SHGs that do not own a thresher.

Table 17: Heterogeneous treatment effects on primary outcomes

Panel A: Income and investments

	(1) tot_income	(2) fem_entrp_inc	(3) biz_investm
T1	1.642**	0.797	0.983
	(0.3723)	(0.5720)	(1.3076)
T2	-0.735*	0.145	1.022
	(0.3637)	(0.6106)	(0.9380)

	(1) tot_income	(2) fem_entrp_inc	(3) biz_investm
SHG is 3+ years	0.844**	0.704	1.005
	(0.2128)	(0.5723)	(0.7091)
T1 x SHG is 3+ yrs	-1.953**	-1.139	-1.159
	(0.3974)	(0.7904)	(1.3750)
T2 x SHG is 3+ yrs	0.674+	1.765*	3.172**
	(0.3784)	(0.8803)	(1.1998)
Constant	9.661**	-0.783	-1.560
	(0.9427)	(1.1589)	(1.4889)
Observations	1,662	1,662	1,662
Adjusted R^2	0.011	0.151	0.304

	(1) tot_income	(2) fem_entrp_inc	(3) biz_investm
T1	-0.102	-0.777	-0.812
	(0.2868)	(0.5363)	(0.5026)
T2	-0.042	1.122	2.942**
	(0.2508)	(0.7572)	(0.9002)
Owns thresher	0.438+	-0.330	-0.299
	(0.2235)	(0.4635)	(0.5177)
T1 x owns thresher	-0.271	0.990	1.378+
	(0.3779)	(0.6925)	(0.7754)
T2 x owns thresher	-0.175	1.302	1.984*
	(0.3032)	(0.8121)	(0.9403)
Constant	10.330**	0.162	-0.275
	(0.9165)	(1.0456)	(1.3351)
Observations	1,662	1,662	1,662
Adjusted R^2	0.005	0.151	0.303

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Log (total) household income
Model 2 - Income from female-owned enterprise
Model 3 - Total investments in female-owned enterprise
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel B: Asset ownership and control

	(1) assets_owned	(2) sale_input	(3) purchase_input
T1	-0.077	0.469**	0.802*
	(0.1776)	(0.1674)	(0.3112)
T2	-0.154	-0.141	0.245
	(0.2985)	(0.3892)	(0.3877)
SHG is 3+ years	-0.037	0.101	0.387
	(0.1211)	(0.1035)	(0.2671)
T1 x SHG is 3+ yrs	-0.204	-0.771**	-1.059**
	(0.2150)	(0.2141)	(0.3412)
T2 x SHG is 3+ yrs	-0.009	-0.138	-0.469
	(0.3234)	(0.3873)	(0.3872)

	(1) assets_owned	(2) sale_input	(3) purchase_input
Constant	0.196	0.644	0.051
	(0.3812)	(0.4769)	(0.5186)
Observations	1,662	1,662	1,662
Adjusted R^2	0.057	0.041	0.039

	(1) assets_owned	(2) sale_input	(3) purchase_input
T1	-0.280*	-0.308*	-0.195
	(0.1388)	(0.1376)	(0.1398)
T2	-0.105	-0.313*	-0.197
	(0.1575)	(0.1264)	(0.1288)
Owns thresher	-0.018	0.006	0.107
	(0.1246)	(0.1191)	(0.1315)
T1 x owns thresher	0.008	0.067	-0.038
	(0.1640)	(0.1739)	(0.1836)
T2 x owns thresher	-0.109	0.085	0.000
	(0.1889)	(0.1768)	(0.1767)
Constant	0.163	0.744	0.385
	(0.4030)	(0.4815)	(0.4763)
Observations	1,662	1,662	1,662
Adjusted R^2	0.057	0.039	0.036

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Number of productive assets respondent owns solely or jointly
Model 2 - Number of productive assets for which respondent makes input in sale decisions
Model 3 - Number of productive assets for which respondent makes input in purchase decisions
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel C: Time allocation (24 hours preceding the survey)

	(1) hrs_ownbiz	(2) hrs_farming	(3) hrs_caring	(4) hrs_chores	(5) selfcare	(6) hrs_chldplus
T1	12.358	-70.407**	-19.081*	65.036**	6.491	4.622
	(26.9501)	(19.5861)	(8.0008)	(21.9284)	(27.5983)	(15.2099)
T2	48.140	-65.336+	-30.908**	51.195	-1.203	39.117
	(36.6237)	(37.9072)	(7.9015)	(31.0823)	(29.7021)	(43.5185)
SHG is 3+ yrs	32.485	-28.613+	-32.105**	21.491	5.419	9.501
	(21.5002)	(14.4033)	(6.7847)	(20.6823)	(22.1332)	(9.0570)
T1 x SHG is 3+ yrs	-14.719	41.050+	26.054**	-66.922*	18.018	-6.123
	(31.0085)	(22.6895)	(9.0343)	(25.6000)	(29.1872)	(15.6087)
T2 x SHG is 3+yrs	-44.502	38.446	35.766**	-64.896+	31.669	-47.099
	(40.0476)	(38.3934)	(9.5257)	(33.1069)	(31.2414)	(44.3713)
Constant	84.485+	37.389	141.977**	301.561**	736.367**	207.266**
	(50.4420)	(43.3128)	(17.4097)	(41.3146)	(59.9842)	(36.2116)
Observations	1,662	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.038	0.180	0.220	0.049	0.132	0.159

	(1) hrs_ownbiz	(2) hrs_farming	(3) hrs_caring	(4) hrs_chores	(5) selfcare	(6) hrs_chldplus
T1	-7.267	-34.887*	-2.650	9.154	33.393*	-13.816
	(19.9176)	(15.4668)	(5.5372)	(12.5781)	(13.9961)	(10.3752)
T2	-6.731	-29.642	2.224	-3.908	37.787*	-0.074
	(18.4787)	(18.8302)	(5.3236)	(13.0130)	(15.3935)	(12.2468)
Owns thresher	-13.580	-3.896	-7.973	-6.158	33.047*	-6.135
	(19.6739)	(15.9152)	(5.9787)	(14.5476)	(13.0714)	(11.1491)
T1 x owns thresher	13.409	6.890	16.058*	-16.472	-19.698	26.578
	(26.8248)	(22.3257)	(8.0233)	(18.3859)	(18.3702)	(16.0610)
T2 x owns thresher	27.070	0.573	1.114	-9.831	-21.202	-8.381
	(24.6364)	(22.4478)	(8.0054)	(20.0869)	(20.2453)	(16.3519)
Constant	122.726**	11.474	115.228**	319.706**	728.579**	221.477**
	(46.2919)	(41.3497)	(16.7763)	(35.9563)	(54.8271)	(35.2356)
Observations	1,662	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.039	0.179	0.219	0.049	0.136	0.161

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Hours spent on own enterprise
Model 2 - Hours spent on farming activities
Model 3 - Hours spent on child/elderly care
Model 4 - Hours spent on domestic chores
Model 5 - Hours spent on self-care/social activities
Model 6 - Hours on other activities combined with childcare
Estimates include controls for baseline characteristics and baseline outcomes.

Turning to the secondary outcomes in Table 18, we do not find any clear evidence of heterogeneous treatment effects on food security, except that the improvement in dietary diversity reported above is concentrated among households with members in SHGs that lack a thresher (Panel A). We find some evidence that the treatments worsened educational outcomes among children in households with members in younger SHGs (Panel B), and that the increase in borrowing is concentrated among members of younger SHGs, particular those in Treatment arm 1 (Panel C).

Table 18: Heterogeneous treatment effects on secondary outcomes

Panel A: Food security

	(1) food_consumed	(2) fs_indx_pca	(3) food_worry	(4) hdds
T1	-0.067	0.075	0.131	-0.127
	(0.1564)	(0.4464)	(0.0910)	(0.3027)
T2	-0.011	-0.186	0.107	0.170
	(0.1813)	(0.4414)	(0.1171)	(0.4647)
SHG is 3+ yrs	0.077	-0.428	-0.035	0.242
	(0.1544)	(0.4365)	(0.0882)	(0.3066)
T1 x SHG is 3+ yrs	0.075	0.048	-0.109	0.327
	(0.1590)	(0.4510)	(0.0906)	(0.3231)
T2 x SHG is 3+yrs	0.008	0.275	-0.089	0.008
	(0.1839)	(0.4528)	(0.1202)	(0.4802)

	(1) food_consumed	(2) fs_indx_pca	(3) food_worry	(4) hdds
Constant	4.849**	0.718	0.244+	6.459**
	(0.2532)	(0.5715)	(0.1403)	(0.5614)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.313	0.085	0.067	0.143

	(1) food_consumed	(2) fs_indx_pca	(3) food_worry	(4) hdds
T1	0.015	0.110	0.017	0.289*
	(0.0411)	(0.1098)	(0.0301)	(0.1353)
T2	-0.017	0.157	0.058*	0.199
	(0.0455)	(0.0988)	(0.0283)	(0.1459)
Owns thresher	0.005	-0.037	-0.012	0.190
	(0.0476)	(0.0827)	(0.0282)	(0.1224)
T1 x owns thresher	-0.013	-0.003	0.016	-0.188
	(0.0595)	(0.0967)	(0.0409)	(0.1581)
T2 x owns thresher	0.024	-0.163	-0.065+	-0.058
	(0.0603)	(0.1208)	(0.0389)	(0.1664)
Constant	4.920**	0.303	0.212*	6.612**
	(0.2164)	(0.3478)	(0.1028)	(0.4586)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.312	0.083	0.067	0.143

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Log (value) of food consumption
Model 2 - Food security index - using principal component analysis. Higher values indicate greater food insecurity.
Model 3 - Food worry in last seven days
Model 4 - Household dietary diversity score
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel B: Life satisfaction, education and SHG decision-making and size

	(1) life_satis	(2) age_approp	(3) shg_dec	(4) shg_size
T1	0.038	-0.165**	0.073	-0.882*
	(0.0330)	(0.0552)	(0.0805)	(0.4193)
T2	-0.056	-0.129+	-0.286*	-0.242
	(0.0552)	(0.0736)	(0.1371)	(0.1915)
SHG is 3+ yrs	0.095**	-0.075*	-0.115	-0.277
	(0.0272)	(0.0327)	(0.0708)	(0.1997)
T1 x SHG is 3+ yrs	-0.034	0.168**	-0.046	0.971+
	(0.0374)	(0.0622)	(0.0879)	(0.4988)
T2 x SHG is 3+yrs	0.054	0.116	0.299*	0.131
	(0.0602)	(0.0860)	(0.1433)	(0.2515)
Constant	0.819**	0.494**	0.573**	1.233
	(0.0874)	(0.1610)	(0.1388)	(0.8426)
Observations	1,662	855	1,616	1,610
Adjusted R^2	0.032	0.179	0.009	0.782

	(1) life_satis	(2) age_approp	(3) shg_dec	(4) shg_size
T1	0.045	0.008	-0.030	-0.147
	(0.0310)	(0.0334)	(0.0451)	(0.1550)
T2	0.000	-0.005	-0.037	-0.218
	(0.0347)	(0.0349)	(0.0449)	(0.1493)
Owns thresher	0.034	0.014	-0.049	-0.129
	(0.0398)	(0.0354)	(0.0516)	(0.1745)
T1 x owns thresher	-0.077	-0.023	0.114	0.410
	(0.0498)	(0.0466)	(0.0723)	(0.2819)
T2 x owns thresher	-0.015	-0.031	0.059	0.205
	(0.0540)	(0.0533)	(0.0736)	(0.2241)
Constant	0.893**	0.423**	0.488**	1.072
	(0.0901)	(0.1541)	(0.1307)	(0.8541)
Observations	1,662	855	1,616	1,610
Adjusted R^2	0.028	0.177	0.005	0.783

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Woman is satisfied with life today
Model 2 - Proportion of children in age-appropriate education
Model 3 - Members are consulted in SHG decisions
Model 4 - Number of SHG members
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Panel C: Loans

	(1) anyloan	(2) shg_loan	(3) bank_loan
T1	0.439**	4.590**	0.188
	(0.1283)	(1.2884)	(0.1960)
T2	-0.067	-1.474	0.407
	(0.2102)	(2.0831)	(0.2610)
SHG is 3+ yrs	-0.057	-0.942	0.131
	(0.0929)	(1.1467)	(0.1194)
T1 x SHG is 3+ yrs	-0.397**	-4.433**	-0.031
	(0.1462)	(1.5024)	(0.2169)
T2 x SHG is 3+yrs	0.055	1.143	-0.201
	(0.2112)	(2.1047)	(0.2757)
Constant	0.472*	5.251*	-0.251
	(0.2121)	(2.2183)	(0.5906)
Observations	1662	1662	1662
Adjusted R^2	0.137	0.126	0.013

	(1) anyloan	(2) shg_loan	(3) bank_loan
T1	0.049	0.245	0.167
	(0.1018)	(1.0102)	(0.1056)
T2	0.016	-0.055	0.265*
	(0.0989)	(0.9914)	(0.1323)
Owns thresher	0.093	0.988	0.156
	(0.1092)	(1.0948)	(0.0946)

	(1) anyloan	(2) shg_loan	(3) bank_loan
T1 x owns thresher	0.006	-0.007	-0.014
	(0.1268)	(1.2815)	(0.1706)
T2 x owns thresher	-0.069	-0.773	-0.101
	(0.1494)	(1.5092)	(0.1836)
Constant	0.378^{+}	3.881^{+}	-0.174
	(0.2159)	(2.2129)	(0.5752)
Observations	1,662	1,662	1,662
Adjusted R^2	0.134	0.121	0.014

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
Standard errors in parentheses. $^{+}$ p < 0.10, * p < 0.05, ** p < 0.01
Model 1 - Woman received any loan
Model 2 - Log (volume) of SHG loan received
Model 3 - Log (volume) of bank loan received
Estimates include village fixed effect, controls for baseline characteristics and baseline outcomes.

Table 19 provides some evidence that the effects of Treatment 2 on entrepreneurial activity are concentrated among households with members in older SHGs, although we also obtain positive point estimates for younger SHGs. We also find some evidence that Treatment arm 1 increased entrepreneurial activities among households with members in younger SHGs (positive and sizeable point estimates but mostly not statistically significant). Table 20 provides some evidence that Treatment arm 1 improved trust among younger SHGs, and that Treatment arm 2 improved trust among SHGs that own a thresher (Panel A).

Table 19: Heterogeneous treatment effects on enterprise outcomes

	(1) num_entrp	(2) fem_entpr	(3) entr_rev	(4) entrp_profit	(5) entr_startup
T1	0.195	0.140	1.120	1.661^{+}	0.657
	(0.1241)	(0.1012)	(1.3537)	(0.8844)	(1.2574)
T2	0.166	0.054	1.769	1.935	1.056
	(0.1445)	(0.0880)	(1.4355)	(1.1884)	(1.1812)
SHG is 3+ yrs	0.106	0.090	1.056	1.144	0.585
	(0.0974)	(0.0675)	(0.9941)	(0.8432)	(0.7537)
T1 x SHG is 3+ yrs	-0.149	-0.154	-0.843	-1.354	-0.358
	(0.1329)	(0.1105)	(1.4340)	(1.0133)	(1.3076)
T2 x SHG is 3+yrs	0.405*	0.468**	2.633	0.930	3.335*
	(0.1599)	(0.1210)	(1.6092)	(1.3627)	(1.3618)
Constant	-0.427*	-0.152	-3.248^{+}	-3.257*	-2.845^{+}
	(0.1868)	(0.1462)	(1.6949)	(1.6206)	(1.4572)
Observations	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.354	0.429	0.331	0.268	0.342

	(1) num_entrp	(2) fem_entpr	(3) entr_rev	(4) entrp_profit	(5) entr_startup
T1	-0.004	-0.045	-0.201	-0.095	-0.212
	(0.0534)	(0.0445)	(0.6025)	(0.5699)	(0.4942)

	(1) num_entrp	(2) fem_entpr	(3) entr_rev	(4) entrp_profit	(5) entr_startup
T2	0.437**	0.384**	3.467**	2.167*	3.441**
	(0.1017)	(0.0915)	(0.9675)	(0.8615)	(0.9131)
Owns thresher	0.015	0.002	-0.052	-0.108	-0.164
	(0.0575)	(0.0521)	(0.5402)	(0.4382)	(0.5103)
T1 x owns thresher	0.114	0.071	1.063	0.959	1.066
	(0.1016)	(0.0710)	(0.8297)	(0.7190)	(0.7726)
T2 x owns thresher	0.198+	0.198*	1.431	1.215	1.373
	(0.1083)	(0.0984)	(0.9113)	(0.9006)	(0.9240)
Constant	-0.313+	-0.050	-2.054	-1.978	-2.076
	(0.1676)	(0.1263)	(1.5210)	(1.4833)	(1.3349)
Observations	1,662	1,662	1,662	1,662	1,662
Adjusted R^2	0.354	0.414	0.330	0.271	0.336

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Number of household enterprises
Model 2 - Number of female-owned enterprises
Model 3 - Log enterprise revenue
Model 4 - Log enterprise profits
Model 5 - Log enterprise start-up capital
Estimates include village fixed effect, and controls for baseline characteristics and baseline outcomes.

Table 20: Heterogeneous treatment effects on social capital

	(1) shared_amt	(2) shared 50% +	(3) return_self	(4) ihs_return
T1	8.602*	0.165*	-2.712	-0.904
	(3.2999)	(0.0785)	(2.5756)	(0.7823)
T2	2.878	0.056	-1.210	-0.093
	(3.2893)	(0.0875)	(3.6847)	(1.2662)
T1 x SHG is 3+ yrs	-8.514*	-0.155+	2.103	0.541
	(3.5369)	(0.0873)	(2.8376)	(0.8338)
T2 x SHG is 3+yrs	-2.451	-0.048	0.648	-0.363
	(3.5927)	(0.0968)	(3.9939)	(1.3001)
Constant	40.960**	0.627**	8.355*	2.188*
	(6.7093)	(0.1765)	(3.7125)	(1.0682)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.020	0.008	0.042	0.035

	(1) shared_amt	(2) shared 50% +	(3) return_self	(4) ihs_return
T1	0.466	0.023	-1.283	-0.824*
	(1.7197)	(0.0469)	(1.6032)	(0.3700)
T2	-1.943	-0.047	-0.913	-0.670+
	(1.6174)	(0.0464)	(1.5834)	(0.3866)
T1 x owns thresher	0.010	-0.012	1.361	0.951+
	(2.5512)	(0.0705)	(2.0344)	(0.5197)
T2 x owns thresher	4.981*	0.115+	0.617	0.491
	(2.2808)	(0.0640)	(2.8313)	(0.6513)

	(1) shared_amt	(2) shared 50% +	(3) return_self	(4) ihs_return
Constant	45.179**	0.709**	10.479**	2.990**
	(6.0431)	(0.1595)	(2.9221)	(0.7449)
Observations	1,662	1,662	1,662	1,662
Adjusted R^2	0.023	0.011	0.037	0.042

Notes: T1 = Treatment arm 1; T2 = Treatment arm 2.
*Standard errors in parentheses. + p < 0.10, * p < 0.05, ** p < 0.01*
Model 1 - Amount offered in trust game
Model 2 - Offered 50% or more
Model 3 - Return on investment in trust game
Model 4 - Inverse hyperbolic sine of return
Note: Estimates include controls for baseline characteristics.

5. Cost analysis

We collected detailed program cost data that are of greatest interest to policymakers and allow for a cost-effectiveness analysis. The costs across ingredients and implementation periods are presented in Table 21.

Table 21: Program component costs

Project year (Jan 2021 to Dec 2023)	2021	2022	2023
Program administration and staff costs			
Cost of all full-time staff who worked throughout any phases of the intervention and implementation, and other costs related to program administration. Includes all overhead costs.	US$33,182	US$87,918	US$90,688
Staff training			
Costs incurred to train staff involved in the intervention (ethics training). This does not include training for enumerators who conducted surveys to collect data for program evaluation.	US$0	US$405	US$1,973
Participant training			
Costs incurred by the program implementer to train participants or beneficiaries.	US$867	US$19,880	US$14,786
Implementation and program-material costs			
Costs of implementing the intervention. This includes the cost of items distributed to participants, the cost of distributing the items, staff transportation to provide services/implement the program, and the cost of creating and maintaining technologies or resources developed for the intervention.	US$22,967	US$50,626	US$59,866
Monitoring costs			
Costs incurred to oversee and monitor program activities and field travel by program staff for monitoring purposes. This category also includes the costs of monitoring supply chains or other systems set up for the intervention. This does not include the cost of data collection for evaluation.	US$757	US$1,586	US$1,740
Total program cost	**US$57,773**	**US$160,011**	**US$167,081**

High-level cost figures are presented in Table 22.

Table 22: High-level project cost

Project year (Jan 2021 to Dec 2023)	2021	2022	2023
Total program cost *The total program costs include various elements such as program administration, targeting, staff training, user training, implementation, and monitoring.*	US$57,773	US$160,011	US$167,081
Number of beneficiaries *Number of beneficiary women SHG members receiving training and exposure visits*	1,669	1,669	1,669
Average cost per beneficiary *Total program cost divided by the number of beneficiaries*	**US$35**	**US$96**	**US$100**

The implementation and material cost figures suggest that the program largely began operations in the second half of 2021. The project was started in Feb 2021; however, COVID-19 affected the first half of 2021 (the Indian government declared May to July 2021 as a lockdown period) and we were unable to commence the enterprise training and exposure program earlier.

However, we utilized that time to develop the enterprise training program modules. For the remaining two and half years, we conducted the implementation meticulously. Most enterprises started in the second half of 2021. There was, however, no quality compromise; overall fidelity had been ensured throughout the intervention, with consistently high uptake (~90%) throughout the intervention period.

6. Discussion

The intervention had a high level of uptake among the intended beneficiaries. As discussed in Section 4.1, SHG members in the treatment arms attended an average of 4.4 of the 5 training sessions offered in both arms. When SHG members were absent from a training session, our attendance record shows that in 80–90% of cases, at least one other member from the same group attended the session.

We estimated ITT effects for the two treatment arms using an ANCOVA specification and obtained positive impacts on a wide range of outcomes. In particular, we find a sharp increase in entrepreneurial activities in Treatment arm 2 (where training focused on value addition through developing new millet products, in addition to postharvest processing and strengthening of market linkages for millet products): there was an increase in female-owned enterprises by roughly 0.5 per household, as well as increases in enterprise startup capital, revenues and profits to 63 times, 67 times, and 16 times, respectively, that of equivalent households in the control arm.

Relatedly, we obtain positive effects on female SHG members in Treatment arm 2 in terms of our empowerment indicators, including greater decision-making roles in entrepreneurial activities, reduced working hours (more time spent on self-care), and an increase in the number of household productive activities over which the respondent has control with regard to income.

Compared to Treatment arm 2, we do not see significant changes in entrepreneurial activities in Treatment arm 1 (where training on value addition through developing new products was not provided), although we do obtain positive effects for some empowerment outcomes: improved self-efficacy, reduced working hours, and improved household dietary diversity.

One point of concern is that we obtain negative effects on SHG members' ownership and control over productive assets in both treatment arms. This finding appears to contradict our estimated effects on the empowerment indicators. The contrast may be due to the fact that our measures of ownership and control of productive assets cover a wide range of activities (not just millet-based enterprises). It is possible that SHG members' increased involvement in millet processing and marketing comes at the expense of control over other productive activities within the household. We aim to explore the reasons behind these shifts in more detail in future work.

Policy implications

This study generated experimental evidence on the impact of services and support related to millet processing and value addition through women's collective-based enterprises. Our results reveal the productivity of millet enterprises, including how millet processing and value addition improve household income, women's empowerment, and other household outcomes.

This evidence can help to guide further development of the OMM, including expanding millet enterprise to other states, while simultaneously improving the welfare of households, and women in particular. The evidence presented in this report can enable the OMM to further develop its strategy for promoting millet enterprises through women's collectives by creating a "business development training program," as established in this project.

There has been recognition by the government that promoting high-productivity enterprises requires considerable investment in machinery (e.g., threshers, pulverizers) without which millet production remains a "backyard" enterprise. This large investment implies significant fixed costs that cannot be borne by individual farm households, and therefore requires a collective approach.

However, constraints on capacity (skills) and markets also exist. Our results suggest that business-development training and support in developing market linkages can overcome capacity and market constraints, and lead to positive entrepreneurial outcomes. The evidence from our intervention can help to inform the development of other government initiatives that aim to improve rural livelihoods through women's collectives.

As 2023 has been declared the International Year of Millets by the United Nations, there has been global attention on the revival of millets to address the twin challenges of climate change and malnutrition. The millet revolution must be demand-driven through consumption at the household, community, and commercial (ecosystem) level.

To increase demand/consumption, the government should promote aggregation on both the demand and supply side: collaboration among producers to help overcome fixed costs, and among consumers to help develop markets. Our second treatment approach can help to increase the consumption of millets by improving aggregate demand.

Women are major actors within food systems; however, globally there is little understanding of women's decision-making in food production and the value chain. This study provides first-hand evidence of this, which may be useful to decision-makers. In India, where SHGs have become alternative informal institutional structures and pillars of government-sponsored poverty alleviation strategies, the business and capacity-building training developed in this project can help to promote agro-enterprises that will not only enhance women's participation in microbusiness but will also have positive economic and empowerment benefits.

7. Conclusion

The main objective of the project was to generate robust evidence on the impact of services and support related to millet processing and value addition for female group-based enterprises—with a view to enabling the OMM to develop its strategy to promote millet enterprises through women's collectives. We evaluated how business-development capacity-building and market linkages related to millet processing and value addition impact entrepreneurial outcomes, household income and welfare, and women's empowerment.

Our evaluation design plan was to generate estimates on whether households and SHGs with certain characteristics have greater capacity to take advantage of the support and services offered through the program, which may help to improve targeting and scaling strategies. This will be useful as the Indian government plans to expand the OMM model to other states. We also evaluated the additional benefits from value-addition activities within the program—evidence that will aid the implementing agency in determining the optimal mix between support for millet processing and value addition in future interventions.

Our treatment effect estimates find a sharp increase in entrepreneurial activities in millet-based value-added enterprises. This suggests that our collective enterprise training program on millet processing and value addition increases the number of female-owned enterprises by roughly 0.5 per household (an additional enterprise in every other household), as well as increases enterprise startup capital, revenues, and profits.

However, the collective enterprise training that supports only millet processing does not have a significant impact on entrepreneurial activities, as it only helps in the primary grain business. The collective training support for processing, however, is effective in improving women's empowerment outcomes such as improved self-efficacy and reduced working hours. Evidence from our intervention may also help to inform the development of other government initiatives that aim to improve rural livelihoods through women's collectives.

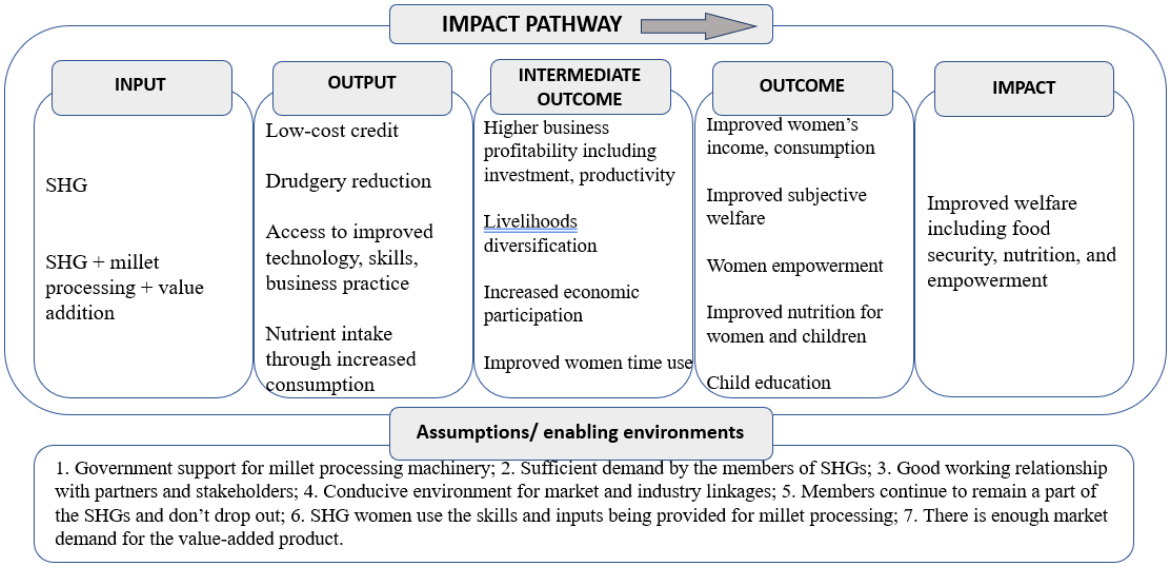
Our research, implementation, and impact assessment agendas are comprehensive, with high implementation fidelity. The project has been problem-driven from the outset, with needs and challenges identified through extensive household survey work and interaction with the target community.

Our intervention has many innovative features. Our training and capacity-building programs are not only gender-sensitive, but also action-oriented. Exposure visits of participating women to successful millet-processing and value-addition initiatives have

been very effective. Our findings suggest that to promote women's enterprises, it is important to develop collective enterprise training and exposure programs that are gender-sensitive and action-oriented. We used mixed methods to evaluate the effects by collecting quantitative and qualitative data. We employed a multi-arm cluster RCT to study the impacts of the provision of support and services related to millet processing compared to the provision of support and services related to millet processing and value addition, and to no intervention.

Appendix A: Theory of change and logical framework

Figure A1: Theory of change



Primary and secondary outcome indicators

The primary and secondary outcomes are provided below.

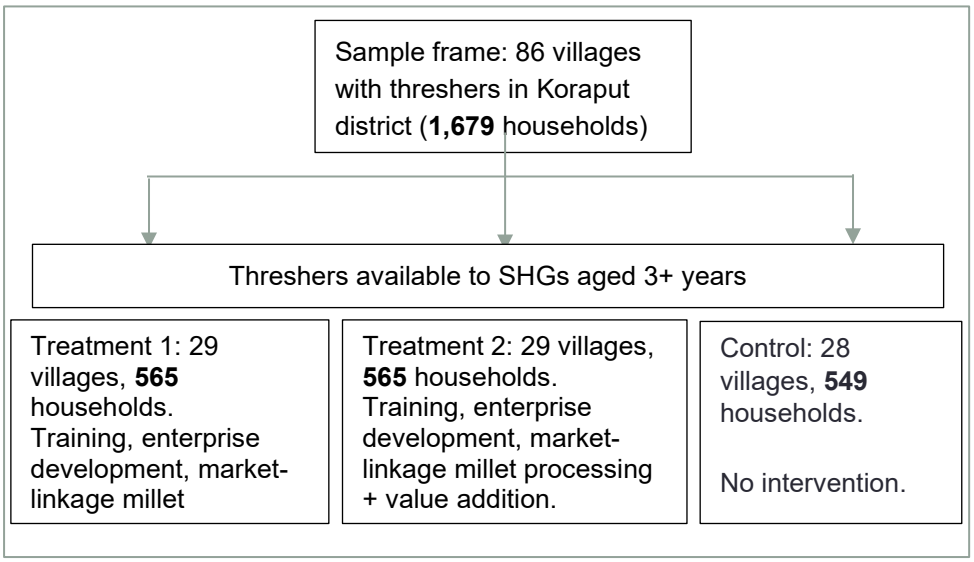
Primary outcomes: Household income, women's income, business investment, nutrient intake for children under 12 months and their mothers, Project-Level Women's Empowerment in Agriculture Index, and five domains of empowerment (decision-making authority regarding household-level production decisions; access to, and control over, productive resources within the household; control over household income; community leadership; and time allocation). All outcomes will be measured using responses to the household questionnaire and women's questionnaire in the baseline and endline surveys.

Enterprise outcomes: Sales revenue or profit, productivity residual, business investment or capital, hours worked, loans from formal or informal sources, business practices (recordkeeping), participation and decision-making on various activities related to enterprise technical knowledge and skills of millet processing and value addition, and livelihood diversification. All outcomes will be measured using responses to the women's questionnaire in the baseline and endline surveys.

Secondary outcomes: Household food consumption (smoothing), child education, dietary diversity and food security, subjective welfare, attitudes towards entrepreneurship and female work, SHG-level outcomes (e.g., social capital, group size, internal lending volume, bank loan volume). All outcomes will be measured using responses to the household questionnaire and women's questionnaire in the baseline and endline surveys.

Appendix B: Evaluation design: Multi-arm RCT

Figure B1: Multi-arm cluster RCT research design



Appendix C: Evaluation timeline

Figure C1: Evaluation timeline, including quantitative and qualitative data-collection plan

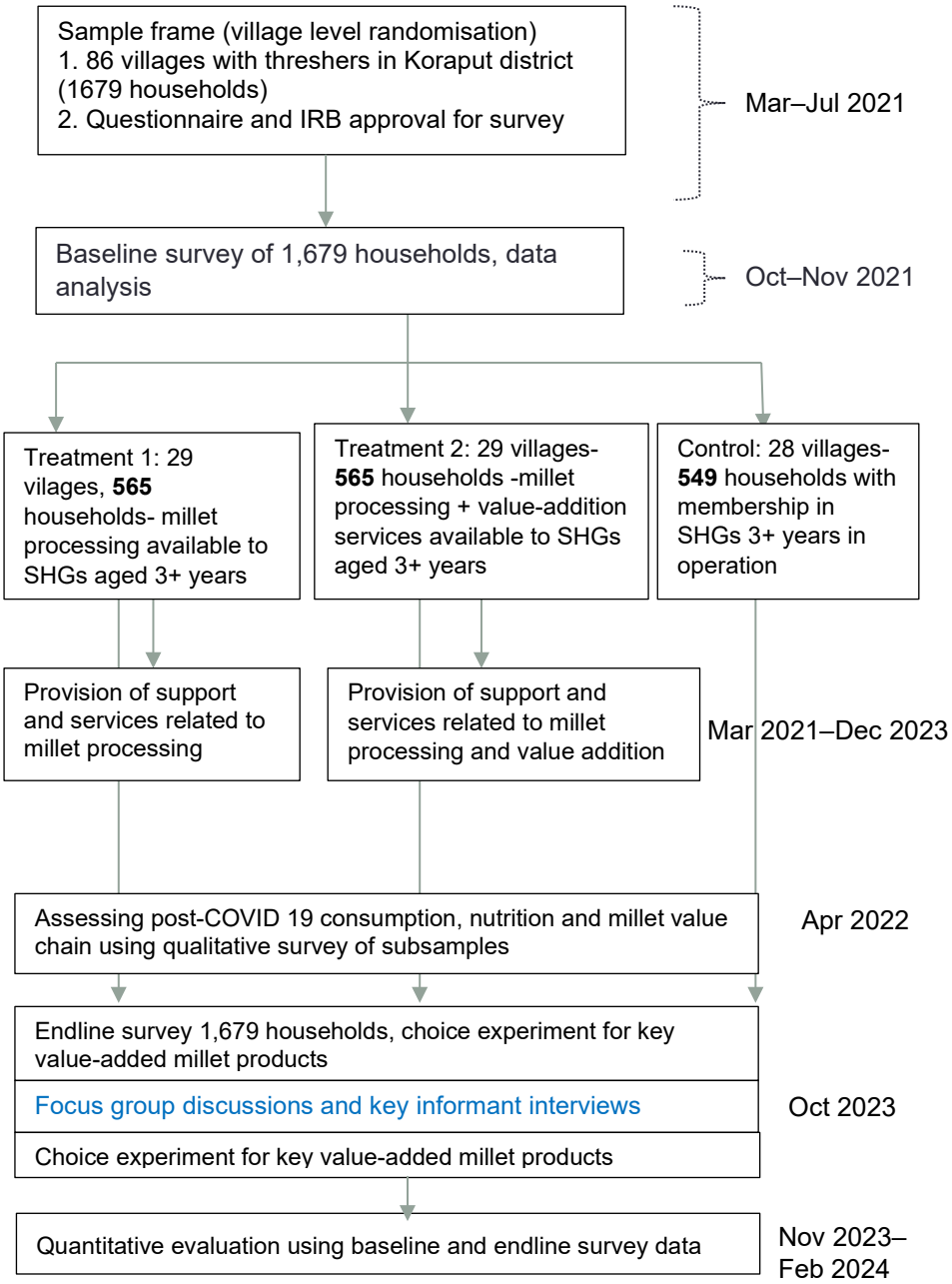


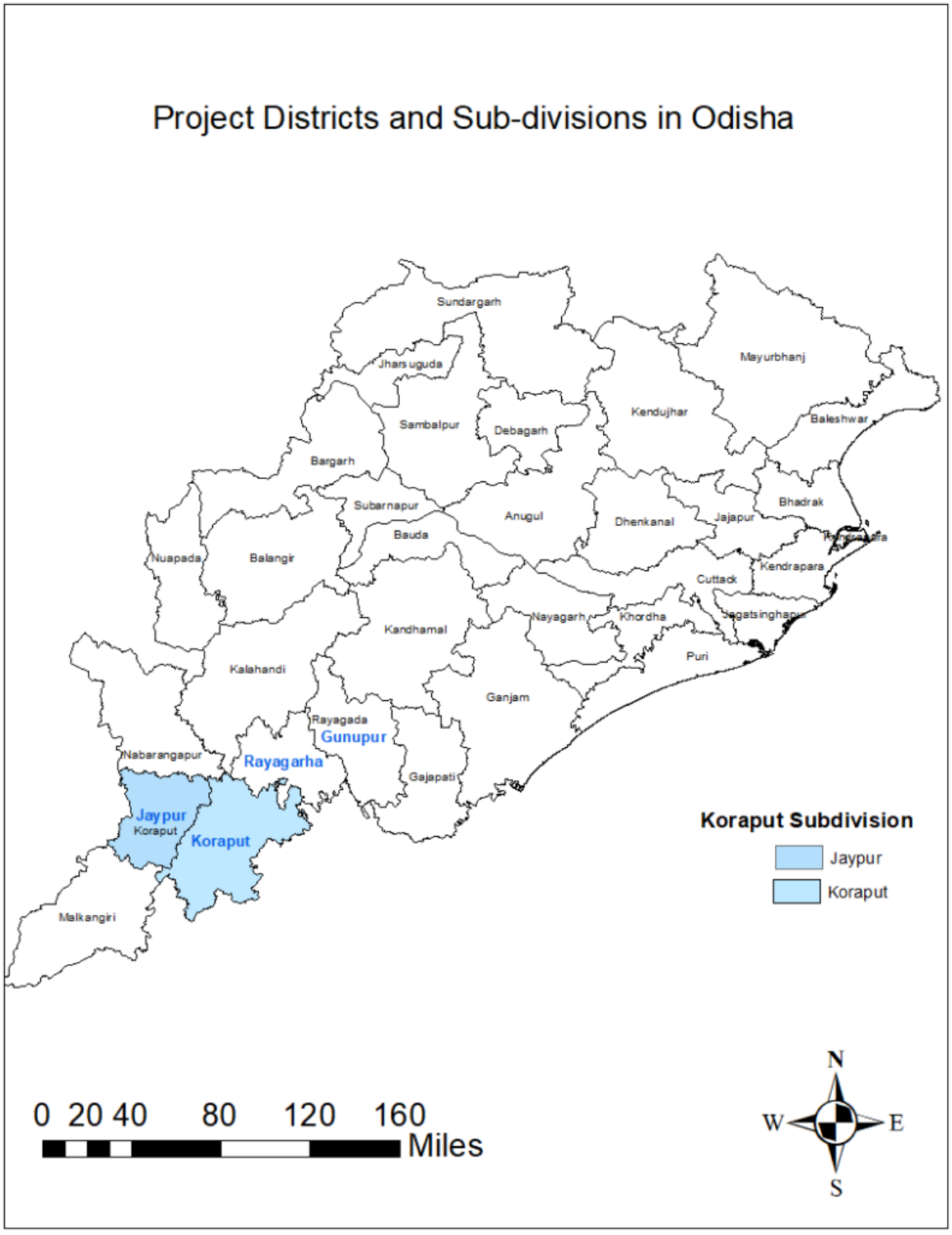
Figure C2: Evaluation timeline and Gantt chart

Activities under each outputs	Deliverables/Milestones	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8	Quarter 9	Quarter 10	Quarter 11	Quarter 12
		Year 1				Year 2				Year 3			
Output 1: Project design and preparation													
Field visit, meeting partners, and general project planning	Background report												
Sample frame selection, treatment allocation for village level randomisation	Research design report												
Output 2: Millet business model , training, capacity building & improve market effectiveness													
Develop project website	Website up and running												
Post-COVID situation in relation to project preparation	Situation analysis report												
Technical support to postharvest and processing of millets	Technical support report, business plan for SHGs												
Value addition through new product development	Documentation of product receipies, list of products												
Enterprise development support	Business plans for all SHGs, quality process												
Gender-responsive training and capacity building	Training module and capacity building report												
Innovation and nutrition profiling and market linkage	Lab test report and product brochure												
Project M&E data, report and update	6 monthy report and enterprise data												
Policy influence and communication	Video documentation, reports, meetings												
Output 3: Survey data , behavioral change, policy and impact assessment													
Baseline survey (survey design, training and implementation)	Baseline survey instrument, data collection												
Data management (clean, revise codebook)	Cleaned electronic baseline data												
Baseline data analysis	Baseline report												
Focus group discussion and key informant interviews	FGD and KII report												
Follow up survey (survey design, training and implementation)	Follow up survey instrument, data collection												
Choice experiment for key value-added millet products	Choice experiment instrument and data												
Data management (clean, revise codebook, publish for public use)	Cleaned electronic follow up data												
Impact Assessment Study/research papers	Papers on various impact ready												

Appendix D: Geographical region

The project is implemented in the district of Koraput, which has an area of 8,807 square kilometers and a population of approximately 1.4 million. In Koraput, SHGs are supported by our partner, WASSAN.

Figure D1: Project geographical area



References

Abadie, Alberto, Susan Athey, Guido W. Imbens, and Jeffrey M. Wooldridge. 2017. *When Should You Adjust Standard Errors for Clustering?* National Bureau of Economic Research Working Paper No. 24003. Cambridge, MA: National Bureau of Economic Research (NBER).

Anderson, Michael L. 2008. Multiple Inference and Gender Differences in the Effects of Early Intervention: A Reevaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American Statistical Association* 103 (484): 1481–95.

Baland, Jean-Marie, Rohini Somanathan, and Lore Vandewalle. 2019. "Socially Disadvantaged Groups and Microfinance in India." *Economic Development and Cultural Change* 67 (3): 537–69

Barooah, Bidisha, Shonar Lala Chinoy, Priyanka Dubey, Ritwick Sarkar, Avantika Bagai, and Francis Rathinam. 2019. *Improving and Sustaining Livelihoods through Group-based Interventions: Mapping the Evidence*, 3ie Evidence Gap Map Report 13. New Delhi: International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/EGM013

Brody, Carinne, Thomas de Hoop, Martina Vojtkova, Ruby Warnock, Megan Dunbar, Padmini Murthy, and Shari L. Dworkin. 2017. "Economic Self-help Group Programmes for Improving Women's Empowerment: A systematic review." *Journal of Development Effectiveness* 9 (1). https://doi.org/10.1080/19439342.2016.1206607

Davidson, Thomas, and Paromita Sanyal. 2017. "Associational Participation and Network Expansion: Microcredit Self-Help Groups and Poor Women's Social Ties in Rural India." *Social Forces* 95 (4): 1695–1724.

Desai, Raj M., and Shareen Joshi. 2014. "Collective Action and Community Development: Evidence from Self-Help Groups in Rural India." *World Bank Economic Review* 28 (3): 492–524

Deininger, Klaus, and Yanyan Liu. 2013. "Economic and Social Impacts of an Innovative Self-help Group Model in India." *World Development* 43: 149–63

Deininger, Klaus, and Yanyan Liu. 2013. "Evaluating Program Impacts on Mature Self-help Groups in India." *World Bank Economic Review* 27: 272–29.

Giné, Xavier, and Ghazala Mansuri. 2014. *Money or Ideas? A Field Experiment on Constraints to Entrepreneurship in Rural Pakistan*. World Bank Policy Research Working Paper 6959. Washington, DC: World Bank Group.

Hayes, Richard J., and Lawrence H. Moulton. 2017. *Cluster Randomised Trials*. 2nd ed. Chapman & Hall/CRC Biostatistics Series.

Holvoet, Nathalie. 2005. "The Impact of Microfinance on Decision-making Agency: Evidence from South India." *Development and Change* 36: 75–102.

Imbens, Guido W., and Donald B. Rubin. 2015. *Causal Inference in Statistics, Social, and Biomedical Sciences*. Cambridge University Press.

McKenzie, David. 2012. “Beyond Baseline and Follow-up: The Case for More T in Experiments.” *Journal of Development Economics* 99 (2): 210–21.

Mishra, Srijit. 2020. *Area, Yield, Production and Value of Produce under the Special Programme for Promotion of Millets in Tribal Areas of Odisha (Odisha Millets Mission), 2017-18, Phase-1*. Nabakrushna Choudhury Centre for Development Studies, Bhubaneswar. http://ncds.nic.in/?q=node/517.

Rubin, Donald B. 1978. “Bayesian Inference for Causal Effects: The Role of Randomization.” *The Annals of Statistics* 6 (1): 34–58.

Rubin, Donald B. 1980. “Randomization Analysis of Experimental Data: The Fisher Randomization Test Comment.” *Journal of the American Statistical Association* 75 (371): 591–93.

Sibhatu, K.T., Krishna, V.V. and Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. Proceedings of the National Academy of Sciences, 112(34), 10657-10662

Swain, Ranjula Bali, and Adel Varghese. 2009. “Does Self-help Group Participation Lead to Asset Creation?” *World Development* 37 (10): 1674–82.

Swain, Ranjula Bali, and Fan Yang Wallentin. 2012. “Factors Empowering Women in Indian Self-help Group Programs.” *International Review of Applied Economics* 26 (4): 425–44.

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