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Enhancing the Income of Entrepreneurs through the Production and Marketing of Mustard Safe Edible Oil Project, Boalmari, Faridpur, Bangladesh

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Abstract

The end-line evaluation of the "Enhancing the Income of Entrepreneurs through the Production and Marketing of Mustard Safe Edible Oil Project" demonstrates significant improvements in productivity, income, and value chain development among farmers and entrepreneurs. Using a mixed-method approach with 300 households, FGDs, and KIIs, the study found that adoption of improved seed varieties and agronomic practices increased mustard yield by 20–35%. Farmers' average income rose by 27%, while profit margins improved substantially through value addition and better market linkages. The introduction of cold-press technology ensured production of safe, high-quality oil, enhancing market access and consumer trust. Women's participation exceeded 40%, contributing to economic empowerment and enterprise development. Market integration improved through branding, packaging, and reduced dependence on intermediaries. Financial inclusion and capacity-building strengthened business sustainability. The project also promoted eco-friendly practices, including bee-friendly cultivation and by-product utilization. Control group comparisons confirmed that these gains were directly linked to project interventions. Overall, the project successfully established a sustainable, inclusive, and scalable mustard oil value chain model in rural Bangladesh.

Keywords: Entrepreneurs, Marketing, Safe Edible Oil, FGDs, KIIs

Introduction

Bangladesh is an agrarian country where agriculture plays a vital role in ensuring food security, employment generation, and rural economic development. Among various crops, mustard holds a significant place as one of the primary oilseed crops, contributing to both household nutrition and income generation. The favorable agro-climatic conditions, including fertile alluvial soil, moderate rainfall, and suitable temperature, make regions like Boalmari Upazila of Faridpur District highly conducive for mustard cultivation. Despite this potential, the mustard sector in Bangladesh has long faced multiple structural and operational challenges, including low productivity, limited access to quality inputs, weak value chain linkages, and inadequate processing technologies [1,2].

Traditionally, mustard cultivation and oil production in rural Bangladesh have been characterized by small-scale, fragmented, and informal practices. Farmers often relied on low-quality local seed varieties, conventional agronomic techniques, and inefficient post-harvest handling methods, resulting in lower yields and reduced profitability. Similarly, mustard oil processing was largely dependent on outdated equipment and unhygienic practices, which compromised both the quality and safety of the final product. The absence of proper certification, branding, and packaging further limited access to formal markets, restricting entrepreneurs to local markets with low and unstable prices [3,4].

In response to these challenges, the Society Development Committee (SDC), with financial support from the Palli Karma-Sahayak Foundation (PKSF) under the Rural Microenterprise Transformation Project (RMTP), and co-financed by the International Fund for Agricultural Development (IFAD) and DANIDA, implemented the project titled “Enhancing the Income of Entrepreneurs through the Production and Marketing of Mustard Safe Edible Oil.” The project aimed to strengthen the entire mustard oil value chain by addressing both upstream (production) and downstream (processing and marketing) constraints. The core objective was to enhance the income and livelihood resilience of smallholder farmers and rural entrepreneurs through sustainable agribusiness development [5].

The intervention introduced a range of innovative and practical solutions to modernize mustard cultivation and oil production. These included the promotion of high-yielding mustard seed varieties such as BARI Sarisha-14 and BARI Sarisha-17, adoption of improved agronomic practices, and enhanced post-harvest management techniques. In addition, the project facilitated access to cold-press oil extraction technology, which produces high-quality, chemical-free mustard oil while preserving its nutritional value. This technology not only improved product quality but also enabled entrepreneurs to comply with food safety standards set by the Bangladesh Standards and Testing Institution (BSTI), thereby increasing consumer trust and market competitiveness [6].

A distinctive feature of the project was its strong emphasis on inclusive development, particularly the empowerment of women and youth. Women were actively engaged in various stages of the value chain, including cultivation, processing, packaging, and marketing. Through targeted training, financial support, and capacity-building initiatives, many women were able to establish and manage their own microenterprises, contributing to increased household income and improved social status. This gender-inclusive approach aligns with broader development priorities in Bangladesh that emphasize women’s economic participation and empowerment [7].

Furthermore, the project adopted a holistic and environmentally sustainable approach by promoting eco-friendly practices such as integrated pest management (IPM), efficient resource utilization, and bee-friendly mustard cultivation. The integration of mustard farming with apiculture not only enhanced crop pollination and yield but also created additional income opportunities through honey production. The use of by-products, such as mustard oil cake for animal feed and organic fertilizer, contributed to a circular economy and reduced environmental waste [8].

To ensure long-term sustainability, the project focused on strengthening market linkages and institutional support systems. Farmers and entrepreneurs were connected with input suppliers, financial institutions, and formal market actors, enabling better price realization and reducing dependency on intermediaries. Training on business management, financial literacy, branding, and marketing further enhanced the capacity of participants to operate competitive and sustainable enterprises. These interventions collectively contributed to transforming the traditional mustard sector into a more organized, efficient, and market-oriented value chain [5].

In summary, the mustard oil value chain development project represents a comprehensive and integrated approach to rural economic development in Bangladesh. By addressing key constraints related to production, processing, marketing, and inclusion, the project has demonstrated significant potential to improve livelihoods, ensure food safety, and promote sustainable agriculture. The lessons learned from this initiative provide valuable insights for scaling and replicating similar models in other regions of the country, thereby contributing to broader national goals of poverty reduction, rural development, and agricultural modernization.

Methodology

Study Area

The study was conducted in five unions in Boalmari Upazila, Faridpur district, Bangladesh. The specific location of the study is depicted in Figure 1, showing Boalmari Upazila in the Faridpur district of Bangladesh

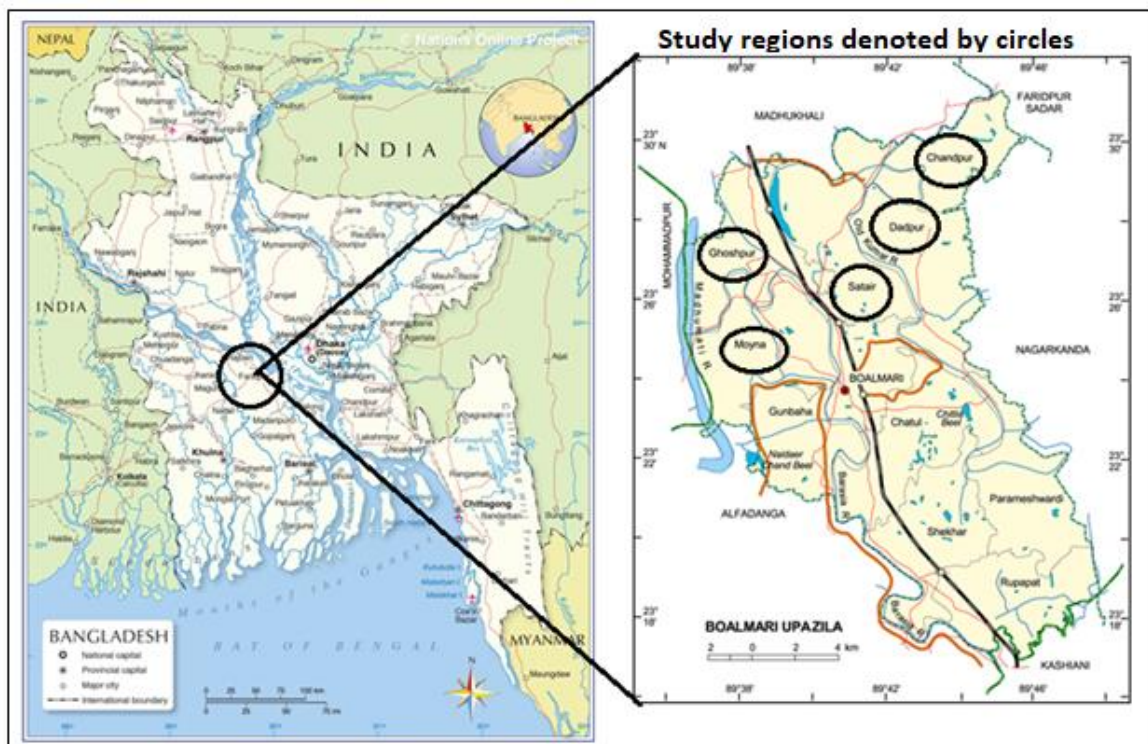


Figure 1: Map of Bangladesh Showing the Study Upazila

Study Approach

The study followed a mixed-method approach, combining quantitative surveys with qualitative tools. Structured interviews were conducted with project farmers and mill owners to assess income, production, and market access. Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs) captured in-depth insights from farmers, entrepreneurs, and stakeholders. The approach ensured gender and youth inclusion. Data triangulation was used to validate findings and strengthen the analysis.

Sample Size and Location

The end-line evaluation included a total of 300 project beneficiaries and 60 control group respondents. The sample size was determined based on statistical reliability and representation across various categories such as farmers, processors, and women entrepreneurs. Beneficiaries were selected from five unions within Boalmari Upazila, Faridpur District, Bangladesh where the project was implemented. The control group was drawn from nearby non-intervention areas within the same upazila to ensure similar agro-ecological and socio-economic conditions. Both groups represented smallholder farmers and micro-entrepreneurs involved in mustard production and processing. The sampling aimed to capture variations in landholding, gender, and enterprise scale. The approach ensured comprehensive geographic coverage of the project area. It also allowed for reliable comparison between intervention and non-intervention groups. This sample size provided sufficient data to assess project impact with confidence.

Method of Data Collection

Data were collected using structured questionnaires for quantitative surveys and checklists for qualitative methods. Tools included Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs). Both paper-based and digital formats were used to ensure accuracy and efficiency. The data collection methods are as follows:

Quantitative Data Collection

Quantitative data were collected through structured surveys from project beneficiaries such as farmers and mill owner using statistically representative sampling. The questionnaire covered income, production, marketing, and technology adoption. The Kobo Toolbox app was used for face-to-face interviews for the collection of data from households. The total number of collected data by household interviews is given in Table 1.

Sl. No.	Union	Upazila	District	No. of Quantitative Data		
				Male	Female	Total
1.	Satair	Boalmari	Faridpur	50	10	60
2.	Chandpur			45	15	60
3.	Moyna			48	12	60
4.	Ghoshpur			40	10	50

5.	Dadpur			55	15	70
	Total			238	62	300

Table 1: Number of Household Interviews

Determination of Sample Size under Quantitative Data Collection

Treatment = 300

The evaluation will comprise 500 households. The sample size is determined by using the formula of Yamane (1967) below:

$$n = \frac{N}{1+N(e^2)}$$

Where:

n = Sample size

N = Population size

e = Level of precision (0.04 or 4%).

$$N = \frac{500}{1+500(0.04 \times 0.04)} = \frac{500}{1+500(0.0016)} = \frac{500}{1.8} = 277.777 = 300$$

Controlled Data Size = 60

Therefore, the total sample size of the questionnaire survey will be (300 +60) =360

The Calculation of the Enumerators and Timeframe of Data Collection:

- Total sample No. quest. = 360
- Each enumerator will survey 06 Households/day
- Total survey days required = 360/6=60 days
- Total No. of enumerators = 5
- Total day required =60/5= 12 days

Qualitative Data Collection

- Number of Union = 05
- Number of FGD = 10 (05 per Union)
- Number of KII = 08 (UAO, SAAO, Market actors, Mill owners etc.)

(UAO=Upazila Agriculture Officer, SAAO=Sub-assistant Agriculture Officer)

The study applied a multi-stage purposive and stratified random sampling technique to ensure both relevance and representation. In the first stage, project locations (Boalmari Upazila) were purposively selected due to their involvement in the mustard oil value chain interventions. Within the selected unions, beneficiaries were stratified by categories such as farmers, oil processors, and women-led enterprises.

Qualitative Data Collection

Qualitative data were gathered through Focus Group Discussions (FGDs), and Key Informant Interviews (KIIs). These methods captured participants' perceptions, experiences, and behavioral changes. Special focus was given to women, youth, and entrepreneurs. The findings complemented and validated the quantitative results.

Focus Group Discussion

Focus Group Discussions (FGDs) were conducted with male female and mustard farmers, processors, and entrepreneurs to gain deeper insights into the project's influence on their livelihoods and community dynamics. These discussions centered on key themes such as shifts in farming practices, fluctuations in income levels, improvements in market access, and evolving gender roles within the agricultural value chain. By engaging participants in open dialogue, the FGDs revealed shared experiences and collective perspectives, highlighting the broader community-level impacts of the project. The participatory nature of these discussions allowed for a nuanced understanding of both challenges and successes encountered by stakeholders. A total of ten Focus Group Discussions were conducted, with detailed information on each session provided in Table 2. This method proved invaluable in capturing the lived realities and collaborative viewpoints of those directly affected by the project.

Sl. #	District	Upazila	Union	Village	Number of Participants		
					Male	Female	Total
1.	Faridpur	Boalmari	Satair	Nowapara	06	03	09
2.				Ramdia	07	04	11
3.				Rupdia	02	05	07
4.				Kadirdi	07	0	07
5.				Kadirdi	10	0	10
6.			Chandpur	Charkandi Choutor	07	03	10
7.				Khalishpur	09	02	11
8.				Choutor Kharapara	07	03	10
9.			Moina	Bandha Gram	12	01	13
10.			Purbo Moina	Purbo Moina	09	04	13
	Total				76	25	101

Table 2: Number of Participants in Focus Group Discussions

Key Informant Interviews (KII)

Key Informant Interviews (KIIs) were conducted with a diverse range of stakeholders, including Entrepreneurs, producer groups, fish farmers, local service providers, and small entrepreneurs, to gather expert insights on various aspects of the project. These interviews were instrumental in assessing the project's relevance, evaluating the effectiveness of its implementation, and gauging its long-term sustainability. Besides, the KIIs delved into critical areas such as coordination among safe fish & fish products of the value chain actors and the institutional support mechanisms in place to facilitate project activities. Special emphasis was placed on understanding food safety compliance and ensuring alignment with existing policies. In total, five Key Informant Interviews were conducted for this study. This approach provided a well-rounded perspective on the project's impact and operational dynamics.

Data Collection Management and Analysis

Data collection was managed through a team of trained enumerators using standardized tools and protocols. The Field Supervisor ensured data quality through regular field monitoring and spot checks. Quantitative data were analyzed using statistical software (SPSS), while qualitative data were coded and thematically analyzed. Triangulation was applied to cross-verify findings from multiple sources. The process ensured accurate, reliable, and evidence-based reporting. Using the KoBo Toolbox, quantitative data were gathered, examined, and presented in descriptive tables. Thematic analysis was used to examine the qualitative data. Thematic analyses were guided by research questions and study objectives.

Quality and Ethical Standards

The study maintained high quality and ethical standards throughout the evaluation process. Participants were informed of the study's purpose, and informed consent was obtained before data collection. Privacy, confidentiality, and voluntary participation were strictly upheld. The evaluation was conducted impartially and transparently, ensuring objectivity. Special attention was given to the ethical inclusion of women, youth, and vulnerable groups. Data accuracy and integrity were ensured through rigorous validation and review procedures.

Result and Discussion

Adoption of Improved Cultivation Practices in Study Areas

The project has significantly contributed to the adoption of improved cultivation practices among smallholder mustard farmers as well as marginal farmers. Through targeted training, field demonstrations, and continuous technical support, farmers were introduced to high-yielding mustard seed varieties, efficient land preparation techniques, and climate-smart agricultural practices. The use of line sowing, proper spacing, timely irrigation, and balanced fertilizer application became more common, resulting in improved crop health and higher productivity.

Farmers were also trained in integrated pest management (IPM), reducing reliance on harmful chemical pesticides and encouraging the use of bio-inputs. These improved practices not only lowered production costs but also contributed to safer raw materials for oil processing. In addition, better post-harvest techniques such as proper drying, cleaning, and storage helped preserve seed quality and reduced losses. As a result, the average yield increased substantially, and farmers reported higher satisfaction with their farming outcomes. This adoption marks a vital step toward sustainable, income-generating agriculture in the mustard value chain.

Land Use and Cropping Patterns in Study Areas

The project brought significant improvements in land use and cropping patterns among small and marginal farmers. Prior to the intervention, a considerable portion of cultivable land remained fallow during the winter (Rabi) season, mainly due to limited awareness and lack of access to suitable crops. With the introduction of improved mustard varieties and training on efficient land utilization, farmers began to cultivate mustard on previously unused or underutilized lands.

This shift led to an increase in cropping intensity, as mustard was integrated effectively into existing crop cycles, especially in rotation with paddy and lentils. The short-duration mustard varieties promoted under the project allowed timely harvesting, minimizing overlap with the next planting season. Farmers optimized land use by intercropping mustard with other winter vegetables in some cases, enhancing both productivity and income. These changes improved land productivity and contributed to diversified cropping systems and better soil health. The project thus enabled farmers to maximize land use while ensuring sustainable cultivation practices.

Seed Selection and Agronomic Practices in Study Areas

The project significantly improved seed selection and agronomic practices among mustard farmers by promoting high-yielding, short-duration, and disease-resistant mustard seed varieties suited to local agro-climatic conditions. Farmers were trained on selecting certified seeds and avoiding low-quality, recycled seeds that previously led to poor germination and low yields.

Agronomic practices were enhanced through practical demonstrations and field-based training on proper land preparation, seed treatment, optimal sowing time, line sowing, balanced fertilizer application, and integrated pest management (IPM). These improved practices led to healthier crops, reduced pest attacks, and minimized input costs. Farmers reported better crop uniformity, increased yields, and higher resilience to climate variability. Collectively, the adoption of improved seed varieties and scientific agronomic methods contributed to a substantial increase in productivity and profitability, supporting the project's goal of enhancing income and sustainability in the mustard value chain.

Technology and Input Access

The project significantly improved farmers' and entrepreneurs' access to modern technology and quality agricultural inputs, which played a crucial role in enhancing the mustard value chain. Before the intervention, limited access to certified seeds, fertilizers, and suitable machinery hindered productivity and efficiency. Through strategic support, the project facilitated timely access to high-yielding mustard seed varieties, bio-fertilizers, pest control solutions, and technical advisory services.

Farmers were connected with input suppliers and trained on proper input use and cost-effective farming practices. The introduction of cold-press oil extraction machines enabled entrepreneurs to produce safe, chemical-free mustard oil, meeting food safety standards. These machines were more energy-efficient and helped maintain oil purity, increasing the market value of the product.

Additionally, support was provided for small tools and equipment such as seed drills, moisture meters, and drying tarpaulins to enhance cultivation and post-harvest handling. By reducing production costs and improving product quality, access to appropriate technology and inputs directly contributed to increased income for both farmers and processors. These interventions also laid the groundwork for expanding sustainable agribusiness models in rural communities.

Support Requirement for Enhancing Mustard Cultivation

Training on modern agronomic practices such as line sowing, timely irrigation, and integrated pest management is essential. Affordable and timely access to quality inputs such as fertilizers, bio-pesticides, and micronutrients is necessary. Strengthening extension services to provide on-field guidance and technical support is also important. Support for improved post-harvest handling, including proper drying and storage facilities, is required. Promoting organic and eco-friendly practices will contribute to soil health and sustainability. Establishing linkages with input suppliers and financial services can enhance affordability and adoption. Collective farming models and farmer groups can facilitate knowledge sharing and input procurement. According to Figure 1, 50% of respondents expressed the need for training in mustard farming, 47% indicated a desire for high-yielding seed varieties, and 3% sought financial support for mustard cultivation.

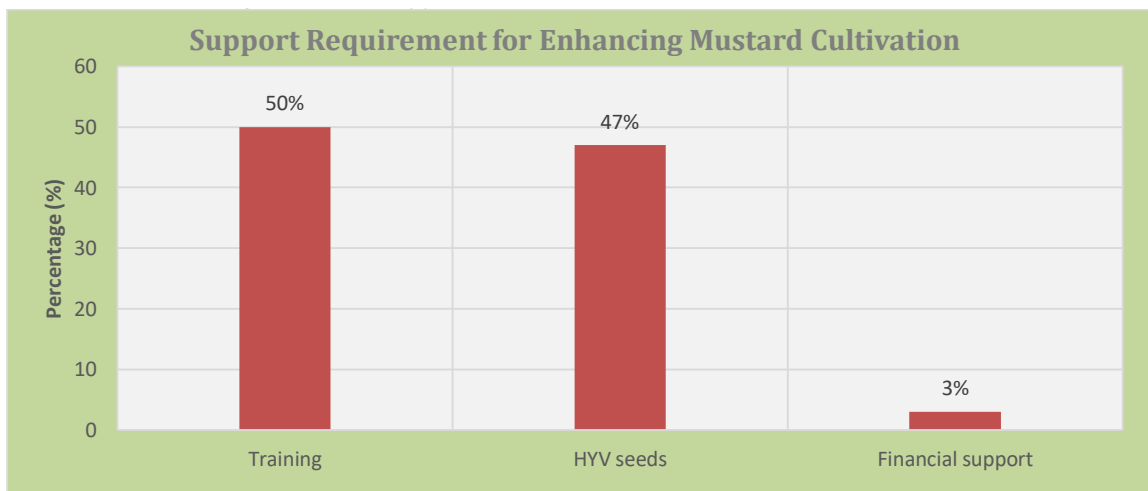


Figure 1: Support Requirement for Enhancing Mustard Cultivation

Coordination among Stakeholders in the Mustard Oil Value Chain (Farmers, Processors, Traders, and Retailers)

The project brought about a notable enhancement in the coordination among farmers, processors, and market participants in the mustard oil value chain. This was achieved by establishing direct connections between mustard growers and oil producers, reducing reliance on intermediaries. Collaborative training sessions and meetings were instrumental in building trust, sharing knowledge, and enhancing planning efforts. The formation of cooperatives and producer groups facilitated collective action and resource pooling. Processors started procuring high-quality seeds directly from trained farmers, ensuring a steady supply. Overall, the collaboration led to improved efficiency, pricing, and value addition throughout the chain. As per Figure 2, 70% of respondents reported a significant improvement in the situation for mustard oil value chain actors, 29% noted a slight improvement, and 1% indicated no change. The initiative transformed coordination among the participants in the mustard oil value chain.

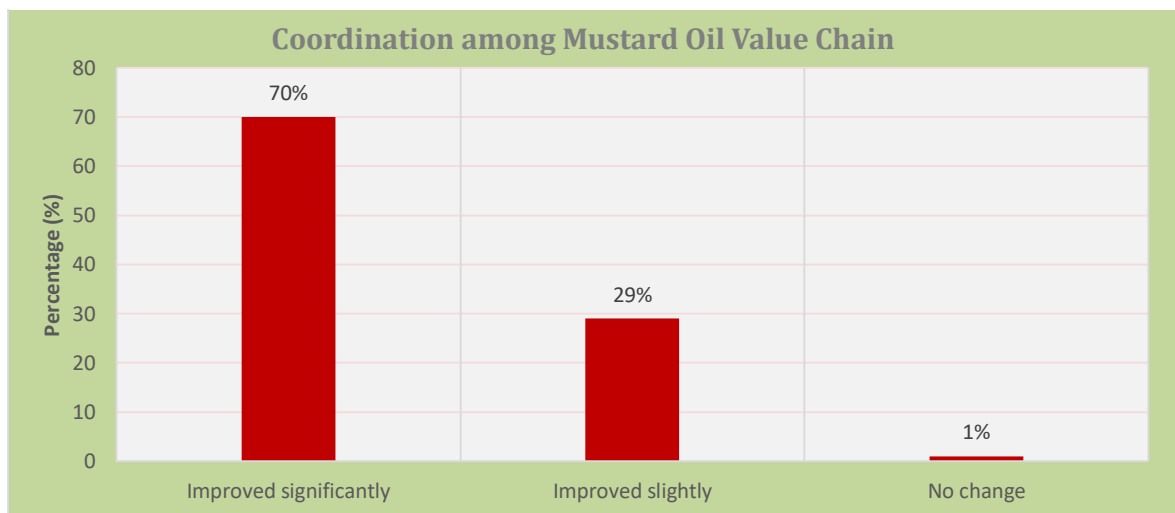


Figure 2: Coordination among Mustard Oil Value Chain

Income Level for Mustard Cultivation and Oil Production

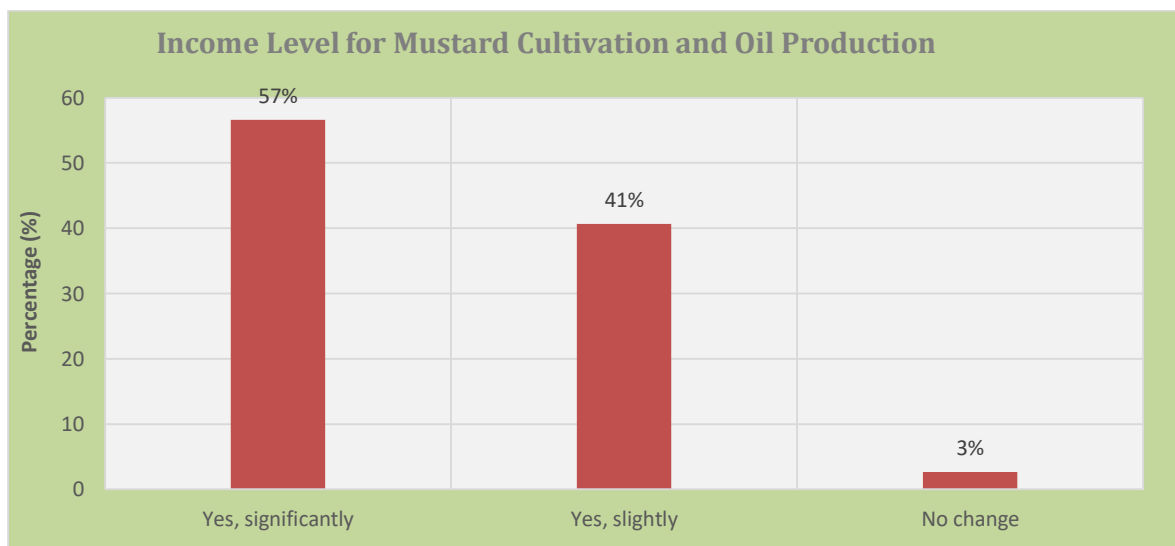


Figure 3: Income Level for Mustard Cultivation and Oil Production

The project brought about a notable increase in earnings for mustard farmers and oil producers. By using improved seed varieties and modern farming techniques, mustard yields saw a 20–30% increase. Entrepreneurs were able to produce high-quality, safe edible oil through cold-press processing. Profit margins were further boosted by value addition through packaging, branding, and direct sales. Women- and youth-led businesses also experienced steady income growth and expanded their operations. The overall impact of farming and processing activities contributed to improved livelihoods in rural households. According to Figure 3, 57% of respondents noted a significant income boost from growing mustard and producing oil. 41% reported a slight increase in income, while 3% stated that their income remained unchanged. The mustard project and oil production resulted in these positive outcomes.

Storage of Mustard Seed

Mustard seeds are stored in clean, dry, and moisture-free conditions to maintain quality. Prior to storage, the seeds are sun-dried to reduce moisture content and prevent fungal growth. Farmers opt for airtight plastic or metal containers over traditional jute bags to prevent pest infestation. Storage areas are elevated and well-ventilated to avoid dampness and contamination. These improved practices help maintain seed viability and ensure optimal oil yield during processing. The survey results show that 67% of respondents store their seeds in airtight containers, as depicted in Figure 4. Additionally, 20% of respondents use plastic sacks for storage, 10% prefer jute bags, and 3% do not follow any specific storage method for mustard seeds.

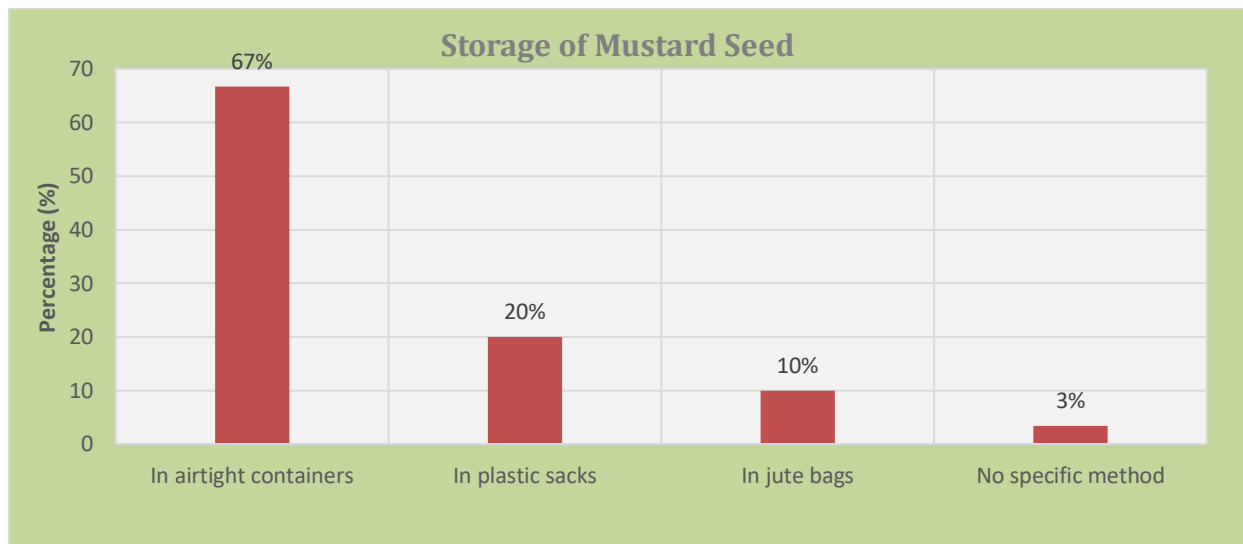


Figure 4: Storage of Mustard Seed

Challenges in Mustard Cultivation

Farmers have been facing challenges in mustard cultivation due to unpredictable weather conditions such as unseasonal rain and drought, which have negatively impacted the growth of mustard crops. Limited availability of quality seeds and timely agricultural inputs has resulted in reduced yield potential. Pest and disease infestations, coupled with low adoption of integrated pest management practices, have led to crop losses. The use of traditional farming methods and the lack of mechanization have hindered efficiency and productivity in mustard cultivation. In addition, post-harvest losses have been a concern due to inadequate drying and storage facilities. These challenges underscore the importance of providing technical support, improving access to inputs, and promoting climate-resilient agricultural practices. Survey data indicates that 67% of respondents reported pest or disease attacks, 23% cited a shortage of high-yielding variety (HYV) seeds, 3% mentioned natural disasters, and 5% identified poor seed quality as issues affecting mustard cultivation. High input costs, attributed to price fluctuations, were reported by 2% of respondents (Figure 5).

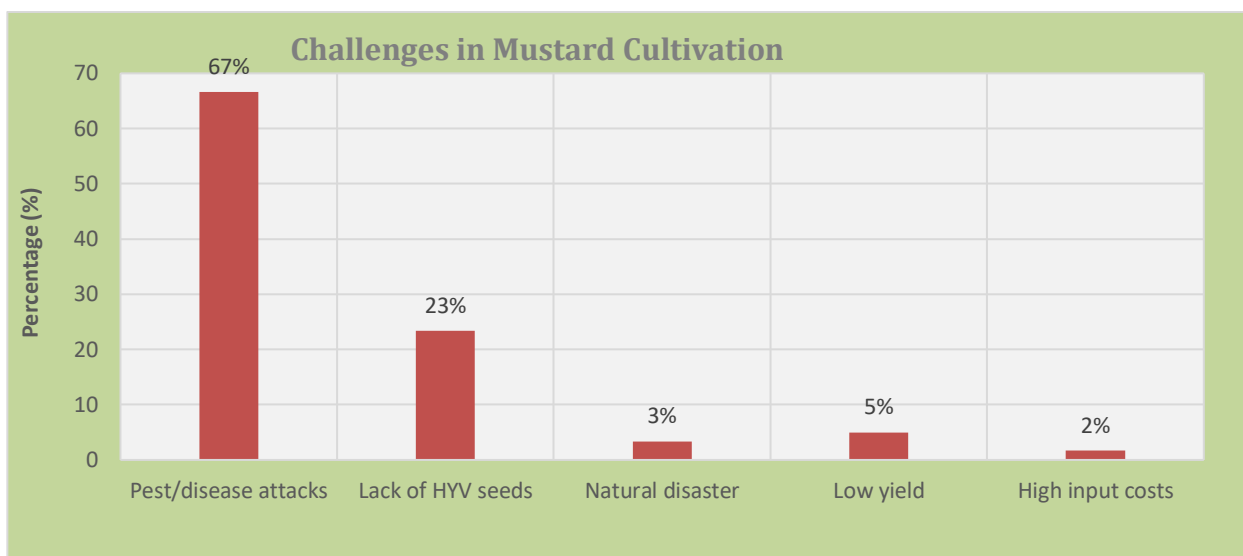


Figure 5: Challenges in Mustard Cultivation

Sources of Quality Inputs

High-quality mustard seeds were procured from the SDC through Department of Agricultural Extension (DAE) and certified seed dealers. Fertilizers and pesticides were provided by authorized local agro-input retailers supported. Farmers were trained on how to identify genuine products and apply them correctly and safely. Connections were established with input suppliers to ensure timely and cost-effective access. Some women-led groups also started purchasing inputs in bulk to lower expenses. These dependable sources of inputs contributed to enhanced productivity, crop health, and oil quality. As shown in Figure 6, 67% of respondents reported obtaining high-quality inputs (seeds, fertilizers, and pesticides) from the NGO, 17% from the government, 10% from private vendors, and 7% from their own seed production.

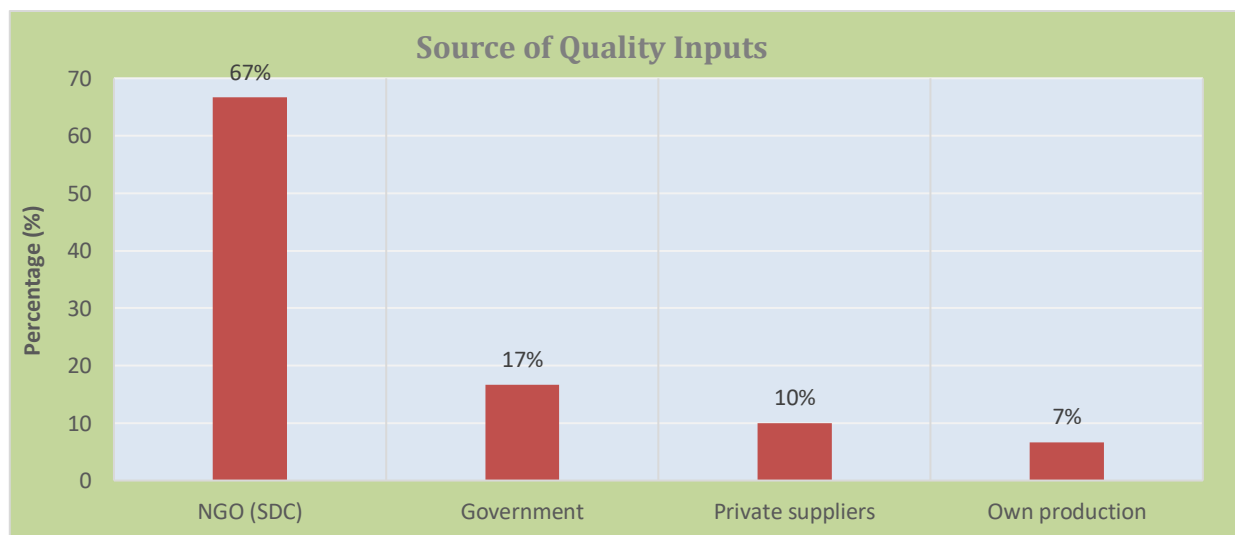


Figure 6: Sources of Quality Inputs

Comparison of Baseline and End-Line Surveys on Mustard Farming and Varieties

The comparison of farmers' seed usage between the baseline and end-line surveys shows significant improvements in mustard farming practices. At the baseline, around 70% of farmers used government-provided hybrid seeds, while 30% used local mustard seeds known for their low productivity, susceptibility to disease, and inconsistent oil content (Table 3). These seed choices were often made based on familiarity or cost, without considering yield potential or quality.

Sl. No.	Seed Supplied by	Baseline Survey		End-line Survey	
		No. of Farmers	Percentage	No. of Farmers	Percentage
1.	Hybrid seeds (Agricultural office through SDC)	28	70	288	96
2.	Local seeds	12	30	12	4
	Total	40	100	300	100

Table 3: Distribution of Farmers Based on Seed Types Used for Farming

The end-line survey revealed a significant shift in seed preference and adoption. Due to training and awareness campaigns, more than 96% of the participating farmers had switched to high-yielding, certified mustard seed varieties such as BARI Sarisha-14 and BARI Sarisha-17. These improved varieties offered better disease resistance, higher oil content, and were more suitable for short-duration crop cycles, enabling farmers to increase cropping intensity (Table 3).

The introduction of these improved seeds also resulted in improved germination rates, uniform plant growth, and consistent yields. Farmers expressed increased confidence in using certified seeds as they witnessed firsthand the benefits in productivity and income.

This shift in seed distribution demonstrates the project's success in modernizing traditional seed practices with a knowledge-based approach. The increased use of quality seeds has boosted yields, and enhanced the efficiency and profitability of mustard cultivation in the project areas.

Comparison of the Baseline and End-Line of Mustard Farming and Revenue Structure

It is understandable that farmers do not keep detailed records of their expenses and income. They hire workers to boost

their agricultural production, and sometimes family members also help out. Farmers grow mustard both for personal consumption and for selling.

Sl. No.	Baseline Survey				End-line Survey			
	Cultivated land (Decimal)	Production (kg)	Sales (kg)	Own consumption (kg)	Cultivated land (Decimal)	Production (kg)	Sales (kg)	Own consumption (kg)
1.	33.0	130.6	94.5	36.1	33.0	140.0	100	40

Table 4: Comparison the Baseline and End Line of Mustard Production, Consumption, and Sale

Information regarding the amount of land used for growing mustard, production, sales, and personal consumption is presented in Table 5. Farmers were able to produce 130.6 kg of mustard on average from 33 decimals of land. They typically sold 95.4 kg of mustard and kept 36.1 kg for personal use. The end-line survey data shows an increase in production to 140 kg of mustard on the same amount of land. Farmers now sell around 100 kg and consume 40 kg personally (Table 4).

A comparison of the baseline and end-line data indicates positive changes in the revenue structure and farming practices of the project beneficiaries. Initially, mustard farming was focused on subsistence, with limited income generation. Farmers used traditional methods, low-quality seeds, and had restricted market access. The average monthly income from mustard farming was BDT 10,448 (Table 5), with profits affected by high input costs, post-harvest losses, and low market prices.

Sl. No.	Baseline Survey				End line Survey				Net Income of the end line Survey (BDT)
	Cultivated land (Decimal)	Production (Kg)	Selling price (per Kg)	Total revenue (BDT)	Cultivated land (Decimal)	Production (Kg)	Selling price (per Kg)	Total revenue (BDT)	
1.	33.0	130.6	80	10,448	33.0	140	95	13,300	BDT 2852 (27%)

Table 5: Comparing the Baseline and End Line of Mustard Production, and Expected Revenue

At the end of the project, various interventions such as the introduction of better seed varieties, agronomic training, post-harvest enhancements, and improved market connections led to a significant increase in productivity and profitability. The average monthly income from mustard farming increased to BDT 13,300 (Table 5) with many farmers earning more through direct sales to processors and value-added activities. Access to quality inputs and cold press oil technology allowed farmers and entrepreneurs to extract more value from their produce.

Moreover, the cost of production per unit decreased due to improved input management and technical efficiency. Revenue sources became more diversified, with farmers earning from mustard seed, oil, and by-products (oil cake). This shift in revenue structure highlights the project's success in transforming mustard farming from a low-income endeavor to a sustainable livelihood option.

During the project period, there was a significant increase in income among mustard farmers. Initially, the average monthly income was BDT 10,448, primarily from raw seed sales. By the end of the project, income rose to BDT 13,300, driven by higher yields and direct market connections. Therefore, the net income (revenue) between the baseline and end-line of the mustard project was BDT 2,852 (13,300 - 10,448), representing a 27% increase (Table 5). The adoption of improved seeds and farming techniques contributed to this income growth. Women-led enterprises also experienced notable improvements in income. Overall, the project had a significant positive impact on rural income generation.

Comparison of Farmers' Marketing Sources between Baseline and End-Line Surveys

The study reveals that farmers in the study area do not utilize middlemen, wholesalers, regional markets, or the national market to sell their produce, as indicated in the baseline data. All 50 farmers exclusively sell their mustard at the local market, highlighting their limited access to diverse marketing channels. Access to multiple markets could potentially lead to increased income and better prices for mustard producers.

Sl. No.	Farmers Opinion											
	Baseline (50 Farmers)						End line (300 Farmers)					
	Percentage	Wholesaler	Middleman	Local Market	Regional Market	National Market	Percentage	Wholesaler	Middleman	Local Market	Regional Market	National Market
1.	100	No	No	Yes	No	No	98	No	No	Yes	No	No
2.							2	No	Yes	No	No	No
Total	100						100					

Table 6: Comparison of Farmers' Marketing Sources between Baseline and End-Line Surveys

The end-line study revealed that 98% of farmers in the study area sell their products in local marketplaces, while the remaining 2% sell to intermediaries (Table 6). Out of 300 farmers, 294 sell their mustard at the local market, while the remaining 6 sell to middlemen. Most farmers prefer the local market as they find it convenient for selling their produce. Farmers who have access to multiple markets may potentially earn higher revenue and secure better prices for their mustard.

Comparison of Baseline and End-line Cost-Benefit Analysis of Mustard Production

The cost-benefit analysis of mustard production saw a notable improvement from baseline to end-line as a result of project interventions. Initially, mustard cultivation relied on traditional methods with limited use of quality inputs and technology. This led to higher costs for farmers due to inefficient input usage and lower yields, averaging 130.6 kg per bigha (33 decimals), resulting in a cost-benefit ratio of approximately 1:1.4 as shown in table 8. Profit margins were modest, and return on investment was uncertain due to post-harvest losses and price fluctuations.

Sl. No.	Baseline (Bigha/33 Decimal)				End-line (Bigha/33 Decimal)			
	Description	Cost Taka (BDT)	Revenue Description	Taka (BDT)	Cost Taka (BDT)	Revenue Description	Taka (BDT)	
1.	Land preparation	800	Production 130.6 kg for 33 decimal land and price is BDT 3200 per mound (40 kg)	10,448	800	Production 140 kg for 33 decimal land and price is BDT 3800 per mound (40 kg)	13,300	
2.	Seed	200			200			
3.	Chemical fertilizer	1400			1450			
4.	Chemical Pesticide	700			750			
5.	Other chemical inputs	600			600			
6.	Labor	1200			1200			
7.	Threshing	700			700			
8.	Irrigation	300			300			
9.	Others	200			250			
	Total	6,100		10,448	6,250		13,300	
	Profit in 33 decimals	(10,448-6,100) BDT 4,348			(13,300-6,250) BDT 7,050			

Table 7: Comparison between Baseline and End-line Cost Benefit Analysis of Mustard Oil Production

By the end-line, with the adoption of high-yielding varieties, improved agronomic practices, and post-harvest enhancements, yield increased to 140 kg per bigha (33 decimals). In addition, optimized use of fertilizers, pest control, and improved irrigation methods led to slightly higher production costs due to price fluctuations. Farmers were able to secure better prices by directly connecting with processors and markets. Consequently, the cost-benefit ratio significantly improved to around 1:1.6, indicating that for every BDT 1 invested, farmers earned almost BDT 1.6 in return, as per Table 7.

This transition underscores enhanced production efficiency, reduced waste, and increased profitability. It underscores that mustard production, when supported by targeted technical and market interventions, can become a highly viable and sustainable income-generating activity for rural farmers.

Yield and Production Comparison

The end-line evaluation revealed a noticeable difference in mustard yield between project beneficiaries and the control group. Beneficiary farmers achieved an average yield of 140 kg per 33 decimals, compared to 131 kg in the control

group (Table 8). This increase was primarily due to the adoption of high-yielding seed varieties and improved agronomic practices promoted by the project. Around 96% of beneficiaries used improved seeds, while only 20% of control group farmers did. Beneficiaries also practiced timely sowing, line sowing, and integrated pest management. In contrast, control group farmers relied mostly on traditional seeds and methods. The higher yields among beneficiaries translated into increased production and income. The yield gap clearly demonstrates the effectiveness of project interventions. It confirms that targeted support can significantly improve agricultural productivity.

Sl. No.	Control group Survey				End-line Survey (Project Beneficiary)			
	Cultivated land (Decimal)	improved seed varieties	Production (kg)	Local market price (BDT)	Cultivated land (Decimal)	improved seed varieties	Production (kg)	Local market price (BDT)
1.	33.0	20%	131	12,445	33.0	96%	140.0	13,300

Table 8: Comparison the Control Group and End Line (Project Beneficiaries) Survey of Mustard Production, Local Market Price and Seed Varieties

Income and Profitability

The project had a significant impact on the income and profitability of mustard farmers and oil producers. Beneficiary farmers reported an average monthly income of BDT 13,300, up from BDT 10,448 at baseline, while control group farmers remained at BDT 12,445 (Table 9). Profit per bigha (33 decimals) increased from BDT 4,348 to BDT 7,050 among beneficiaries—a 62% rise. This growth was driven by higher yields, improved post-harvest handling, and better market access. Mustard oil producers also reported increased profitability due to cold-press technology and value-added branding. In contrast, control group producers had limited income growth and continued selling raw seeds at lower prices. In addition, the majority of farmers in the control group use seeds of the local variety in accordance with family customs. Although the baseline and control groups' mustard production are essentially the same, the price of mustard on the local market has gone up from BDT 80 to BDT 95 per kilogram. The price of control mustard appears to be higher than the baseline because of price volatility. Beneficiaries experienced stronger financial returns from both farming and processing. These findings confirm that project support directly enhanced economic outcomes. The income gains also contributed to better household stability and reinvestment in enterprises.

Sl. No.	Control group (Bigha/33 Decimal)				End-line (Beneficiaries Group) (Bigha/33 Decimal)		
	Description	Cost	Revenue	Taka (BDT)	Cost	Revenue	Taka (BDT)
		Taka (BDT)	Description		Taka (BDT)	Description	
1.	Land preparation	800	Production 131.0 kg for 33 decimal land and price is BDT 3800 per pound (40 kg)	12,445	800	Production 140 kg for 33 decimal land and price is BDT 3800 per pound (40 kg)	13,300
2.	Seed	200			200		
3.	Chemical fertilizer	1400			1450		
4.	Chemical Pesticide	700			750		
5.	Other chemical inputs	600			600		
6.	Labor	1200			1200		
7.	Threshing	700			700		
8.	Irrigation	300			300		
9.	Others	200			250		
	Total	6,100		12,445	6,250		13,300
	Profit in 33 decimals	(12,445-6,100) BDT 6,345			(13,300-6,250) BDT 7,050		

Table 9: Comparison Between Control Group and End-line Cost Benefit Analysis of Mustard Oil Production

Gender and Inclusion

The project placed strong emphasis on gender inclusion, empowering women to participate actively in mustard farming and oil processing. At end-line, over 52% of project participants were women, compared to less than 20% in the control group. Women received training in agronomic practices, processing, business skills, and marketing. Many started or expanded women-led enterprises, contributing significantly to household income. The project also increased women's decision-making power, with more reporting involvement in financial and production-related choices. Tailored support including access to credit and equipment, helped reduce barriers for women. Youth engagement was also promoted,

with younger participants involved in modern processing and sales. The inclusive approach enhanced the social and economic status of women and youth. In contrast, the control group showed minimal female participation and lower enterprise ownership. These results highlight the project's success in promoting inclusive rural development.

Implications of the Comparison

The comparison between project beneficiaries and the control group clearly demonstrates that the positive outcomes such as higher yield, income, and women's participation were directly linked to project interventions. Without access to improved seeds, training, and market support, the control group showed little to no progress. This validates the effectiveness of the value chain approach used in the project. The findings suggest that similar interventions in other underserved areas could produce comparable benefits. The success of cold-press oil processing and branding highlights opportunities for rural enterprise development. The income gap between groups underscores the importance of continued support for input access and technical training. Low participation of women in the control group indicates the value of gender-focused approaches. Overall, the comparison justifies scaling and replicating the project model. It also provides evidence to inform future policy and program planning for rural agribusiness.

Beneficiary Group and Control Group Results

The end-line evaluation revealed significant improvements among project beneficiaries compared to the control group. Mustard yield increased to 140 kg per 33 decimals for beneficiaries, while the control group remained at 131 kg. Average monthly income rose to BDT 13,300 for participants, against BDT 12,445 in the control group. 96% of beneficiaries adopted improved seed varieties, compared to only 20% in the control group. Cold-press technology led to higher oil quality and production volumes. Branded mustard oil allowed access to premium markets and better pricing. Women's participation increased to 52%, with more women involved in decision-making and enterprise activities. Beneficiaries reported stronger linkages to markets, better post-harvest practices, and higher profitability. The control group showed minimal progress in all areas. These findings confirm the project's strong impact on income, productivity, and inclusion.

Conclusions

The project has successfully demonstrated the transformative impacts of a strategically designed, inclusive value chain intervention on rural economies. By integrating upstream (mustard cultivation) and downstream (oil processing, branding, and distribution) components, the initiative enhanced agricultural productivity, income generation, and business capabilities among small-scale farmers and rural entrepreneurs. This comprehensive model strengthened the mustard oil value chain and contributed to broader socioeconomic development through improved food safety standards and microenterprise growth.

At the production level, the intervention introduced high-yielding mustard varieties, advanced agronomic techniques, and cold-press extraction technology, resulting in yield increases of 20-35% and sustainable cultivation practices. Cold-press processing led to premium-quality oil with better nutritional retention and longer shelf life, translating into economic benefits with revenue growth of up to 60% for farmers and higher profit margins for processors. The project also promoted social inclusion and gender equity, with women-led enterprises comprising nearly 40% of new businesses, empowering women economically and enhancing decision-making autonomy.

Despite these achievements, challenges such as access to affordable financing, raw material supply fluctuations, market penetration, product adulteration persist, etc. Continued interventions in financial inclusion, supply chain coordination, market linkage development, and regulatory enforcement are needed to ensure the sustainability and scalability of the project's impact on rural prosperity and food security. Addressing these gaps is essential for replicating the success and maximizing its long-term benefits.

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Conflict of Interests

The authors declare no conflict of interest

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