

Project Completion Report: “Livelihood Generation through Aquaponics-A Bio-Integrated System for People of Bhopal District Using *Azolla-pinnata* as Natural Food”

Project Reference number: NABARD/FSPF/1053/DPR-76/2022-23.

Project Duration: From 29 August 2022 to 28 February 2025.

Inauguration Programme Conducted by SEC, Bhopal (Madhya Pradesh):

On 06 January, 2023, the *Society for Environmental Conservation (SEC)*, Bhopal, proudly inaugurated an aquaponics unit in Bilkhiriya village, Phanda Block, Bhopal, Madhya Pradesh. This significant event was led by the organization's President, Dr. Brijesh Sharma, who emphasized the importance of sustainable practices in rural development.

The ceremony was honored by the presence of several distinguished guests. The Chief Guest, (DGM) of **NABARD**, Bhopal, Smt. Nidhi Sharma, highlighted the potential of aquaponics as a tool for community empowerment. Other notable attendees included Shri Shailendra Padiyar (DDM) Bhopal, Shri Akhilesh Verma (RO), and Smt. Alpana Jain, who expressed their support for the initiative. Local leaders, such as Shri Sarpanch Mishri Lal and Deputy Sarpanch Shri Paramjeet Singh, along with members of the Self-Help Group and other villagers, actively participated in the event, underscoring the community's enthusiasm for this project.

This initiative represents a crucial step toward enhancing the livelihoods of the people in Bhopal District by leveraging aquaponics technology. By integrating the cultivation of *Azolla pinnata* as a natural food source, the project aims to provide sustainable income opportunities and foster economic self-reliance within the community. The successful implementation of this bio-integrated system holds promise for replicating similar models across other rural areas, promoting environmental conservation and social upliftment.





Inaugurated an aquaponics unit at Bilkhiriya village, Phanda Block, Bhopal,









1. Introduction:

The project aims to introduce and establish aquaponics as a sustainable and innovative agricultural practice in the Phanda Block of Bhopal District, Madhya Pradesh. Aquaponics is a bio-integrated system that combines aquaculture (fish farming) and hydroponics (soilless plant cultivation). This approach offers a viable solution for regions facing water scarcity and poor soil quality, making it particularly suitable for areas with limited resources. The primary focus of this initiative is to provide sustainable livelihood opportunities, improve food security, and enhance the efficient utilization of resources for the local population. The project will be implemented in four selected villages within the Phanda Block, with a comprehensive overview detailing the key components and anticipated benefits for the community.

Aquaponics operates on the principle of efficiently using water to produce two types of crops- fish and plants-simultaneously. This integrated system consists of two main subsystems: aquaculture, where fish are raised, and hydroponics, where plants are cultivated without soil. The nutrient-rich water from the fish tanks is circulated through the plant beds, providing essential nutrients to the plants. In turn, the plants help filter and purify the water, which is recirculated back into the fish tanks, creating a sustainable and symbiotic relationship between the two components. The system is particularly advantageous in resource-limited and urban areas, as it allows for the cultivation of both fish and vegetables in a compact, controlled environment. Many types of horticultural plants are suitable for aquaponic systems, though the choice of plants depends on the maturity and stocking density of the fish. Green leafy vegetables with low to medium nutrient requirements, such as capsicum, tomatoes, lettuce, cabbage, basil, spinach, chives, herbs, and watercress, are well adapted to these systems.

Aquaponics is essentially a Recirculation Culture System. Fish are fed high-quality floating pellet feed, and the waste generated by the fish is pumped into bio-filter troughs containing horticultural plants. The flow rate of water is carefully managed, often with the use of timers, to optimize nutrient delivery and water usage. This system's organic nature ensures that both fish and plants are free from synthetic chemicals. While the initial investment for setting up an aquaponics system can be relatively high, the ongoing costs are lower, and the system offers reasonable returns. The advantages include reduced water usage, minimal land requirements, waste renewal, and lower labour needs. The symbiotic relationship between plants and animals in an aquaponic system not only supports sustainable agriculture but also promotes environmental conservation. Fish excreta provide essential nutrients for plant growth, while plants help clean the water, creating an optimal environment for fish to thrive.

This project not only aims to demonstrate the feasibility and benefits of aquaponics but also to foster community engagement and education about sustainable agricultural practices. Through this initiative, the local population will gain access to fresh, organic produce and fish, contributing to improved nutrition and food security. The project will also provide training and resources to empower the community to continue and expand aquaponics practices, ensuring long-term sustainability and resilience.

2. Project Overview

The project aimed to introduce aquaponics as a sustainable agricultural practice in the Phanda Block of Bhopal District, Madhya Pradesh. The initiative focused on integrating fish farming (*Pangasius-pangasius*) with hydroponic vegetable cultivation, utilizing *Azolla-pinnata* as a

natural fish feed. This approach sought to improve local resource productivity, conserve water, and generate livelihoods for 100 beneficiaries across four villages: Bilkhiriya, Sankal Tanda, Bangrasiya, and Bagroda.

3. Total Project Sanction Cost (NABARD): ₹ 14,98,910/-.

The total expenditure was ₹11,99,128/- covering all phases of the project, including aquaponics system material procurement, training, and demonstration setups.

4. Key Components of the Aquaponics Project:

i). Fish Farming (Aquaculture)

Fish farming in this project focused on cultivating *Pangasius-pangasius*, a freshwater fish species known for its adaptability to various environmental conditions and high market value. This species was selected due to its resilience, ease of cultivation, and suitability to the region's climate and water availability. The fish farming component was crucial not only for food production but also for providing essential nutrients to the hydroponic plants through their waste.

Implementation Details:

- **Fish Tanks:** Custom-built tanks were installed to maintain optimal water quality and temperature for the *Pangasius* fish. The tanks were designed to allow easy cleaning and monitoring.
- **Stocking Density:** Fish were stocked at a density of 10 to 20 kg per 1000 liters of water, ensuring a balanced ecosystem and healthy growth rates.
- **Water Quality Management:** Regular monitoring and maintenance were conducted to maintain water parameters such as pH, dissolved oxygen, and ammonia levels, crucial for the health of the fish.

ii). Hydroponic Vegetable Cultivation

Hydroponic systems were established to grow various vegetables without the need for soil, utilizing the nutrient-rich water from the fish tanks. The integration of these systems enabled efficient nutrient cycling and water use, as plants absorbed the nutrients from the fish waste, thus purifying the water that was recirculated back to the fish tanks.

Implementation Methodology: The following methodology was adopted for the successful implementation of the aquaponics system project:

The aquaponics project in the Phanda Block of Bhopal District utilized three distinct hydroponic systems to optimize plant growth and resource use within the aquaponics setup. Each system was selected based on its suitability for different types of crops and its ability to maximize space and nutrient efficiency. The three primary hydroponic systems implemented were the Nutrient Film Technique (NFT), the Raft System (Deep Water Culture - DWC), and the Vertical Aquaponics System.

System Types: Three primary hydroponic systems were implemented:

a). Nutrient Film Technique (NFT) System:

The Nutrient Film Technique (NFT) was employed to grow leafy greens and other small plants in a space-efficient manner. In this system, a thin film of nutrient-rich water continuously circulated through horizontal channels or pipes. The plant roots were exposed to this nutrient film, allowing them to absorb essential minerals and nutrients directly from the water. NFT is particularly effective for leafy greens like lettuce, spinach, and basil, which have relatively low nutrient requirements and benefit from the constant supply of nutrients and oxygen provided by the thin water film. The system's design helps minimize water use and space, making it an ideal choice for areas with limited resources.

b). Raft System (Deep Water Culture - DWC):

The Raft System, also known as Deep Water Culture (DWC), was implemented to support the mass production of various plants. In this setup, plants were grown on floating rafts that floated on a deep-water channel. The roots of the plants were submerged in the nutrient-rich water, which provided both nutrients and oxygen directly to the plants. This system allows for high-density planting and efficient nutrient absorption, making it suitable for larger-scale production. The DWC system also supports the growth of a diverse range of plants, including larger vegetables and herbs, due to its ability to maintain a stable and oxygenated nutrient solution.

c). Vertical Aquaponics System:

To maximize the use of available space and increase planting density, the Vertical Aquaponics System was utilized. This system involved stacking plant containers vertically above the fish tanks. By using vertical space, the system allowed for high-density planting in a compact footprint, making it particularly advantageous in areas where land is limited. The vertical arrangement also facilitated better light exposure and air circulation for the plants. This system was designed to complement the fish tanks below, creating a visually efficient and productive integration of fish and plant cultivation. The vertical design helped optimize resource use and improve overall system productivity.

iii). Use of *Azolla-pinnata* as Natural Fish Feed

Azolla-pinnata (duckweed) a fast-growing aquatic fern, was employed as a natural and cost-effective feed for the Pangasius fish. This not only reduced the dependency on commercial fish feeds but also contributed to the sustainability of the system. *Azolla-pinnata* is rich in protein and essential nutrients, making it an ideal feed choice that promotes healthy fish growth.

Implementation Details:

- **Cultivation:** *Azolla* was cultivated in designated ponds and then harvested regularly to feed the fish. Its rapid growth rate ensured a steady and reliable food source.

- **Nutritional Benefits:** The use of *Azolla-pinnata* enriched the fish diet, enhancing their growth rates and health, while also reducing the operational costs of purchasing commercial feed.

5. Objectives Achieved: The primary objectives of the project were;

- *Interventions to improve the productivity of locally available resources by imparting the low-cost Aquaponics technology with reference to integrated Pangasius-pangasius fish culture enhancement using Azolla-pinnata as natural fish food.*

i). Low-Cost Aquaponics Technology

The project focuses on enhancing the productivity of locally available resources through the introduction of low-cost aquaponics technology. This innovative approach integrates the culture of *Pangasius-pangasius* and Indian Major Carps, such as Rohu (*Labeo rohita*), Catla (*Catla catla*), and Mrigal (*Cirrhinus mrigala*), with the cultivation of *Azolla-pinnata*, a fast-growing aquatic fern used as a natural fish food. The adoption of this technology aims to optimize resource use, reduce costs, and support sustainable agricultural practices in the region.

ii). Integrating Fish Culture and Natural Feed

The choice of *Pangasius-pangasius* and Indian Major Carps is strategic, given their adaptability to a range of water conditions, robust growth rates, and high market demand. These species are well-suited for aquaponics systems, where they can be raised in controlled environments that maximize growth and health. Integrating these fish species into the aquaponics setup offers several benefits, including efficient nutrient recycling, enhanced water quality through bio-filtration, and consistent production of high-quality fish protein.

Azolla pinnata plays a crucial role in this system as a natural and cost-effective fish feed. This aquatic plant is rich in proteins, amino acids, vitamins, and minerals, making it an excellent supplementary diet for the fish. The cultivation of *Azolla-pinnata* not only reduces the dependence on commercial fish feed but also lowers the overall operational costs of the aquaponics system. Furthermore, *Azolla* has a high growth rate, allowing for rapid biomass production that can support continuous feeding needs.

iii). Advantages of Low-Cost Aquaponics Systems

The introduction of low-cost aquaponics technology offers several advantages, particularly in regions with limited financial and natural resources. The system's design prioritizes affordability and efficiency, using locally sourced materials and simplified technology to minimize setup costs. By utilizing a closed-loop water recirculation system, aquaponics conserves water—a critical factor in areas experiencing water scarcity. This sustainable method of food production is environmentally friendly, as it requires minimal chemical inputs and generates negligible waste.

In addition to providing a reliable source of fish and vegetables, the integration of *Azolla* as a natural feed promotes ecological balance within the aquaponics system. The plant not only serves as food for the fish but also helps in maintaining water quality by absorbing excess

nutrients, which could otherwise lead to water quality issues. This dual role of *Azolla* underscores the symbiotic relationships inherent in aquaponics, where each component supports the other, resulting in a resilient and self-sustaining ecosystem.

iv). Community Impact and Sustainability

The implementation of this project is expected to have a significant impact on the local community by enhancing food security, providing economic opportunities, and promoting sustainable agricultural practices. By training local farmers and stakeholders in the principles and techniques of aquaponics, the project aims to empower them to adopt this technology independently. This knowledge transfer is essential for the long-term sustainability and scalability of the system, allowing for continued innovation and improvement.

The integration of *Pangasius-pangasius*, Indian Major Carps, and *Azolla-pinnata* into a low-cost aquaponics framework represents a practical and effective approach to improving resource utilization in the region. This initiative not only supports local food production but also aligns with broader goals of environmental conservation and economic development. As the community embraces this sustainable agricultural practice, the potential for replication and expansion increases, paving the way for a more resilient and productive agricultural landscape.

- *Aquaponics is an intriguing method of conserving water while producing high-quality food.*

i). Promoting Aquaponics for Water-Efficient, High-Quality Food Production

Aquaponics represents a cutting-edge approach to sustainable agriculture, combining aquaculture (fish farming) and hydroponics (soilless plant cultivation) in a synergistic system. One of the most compelling advantages of aquaponics is its exceptional water efficiency, making it an ideal method for producing high-quality food, including a variety of vegetables and fish, particularly in regions with limited water resources.

ii). Water Efficiency in Aquaponics

Traditional farming methods often require significant amounts of water, a critical and increasingly scarce resource. In contrast, aquaponics systems utilize a closed-loop water recirculation process, drastically reducing water consumption. The water in an aquaponics system is continuously circulated between the fish tanks and plant beds. Fish waste provides essential nutrients for the plants, which, in turn, help filter and purify the water before it is returned to the fish tanks. This efficient use of water means that aquaponics systems typically use up to 90% less water than conventional agriculture, making it an incredibly resource-efficient way to grow food.

iii). High-Quality Food Production

Aquaponics enables the simultaneous cultivation of fish and a diverse array of vegetables, producing two types of food from the same system. This dual production capability is particularly beneficial in maximizing the output from a given area, which is crucial in urban

settings or regions with limited arable land. The controlled environment of aquaponics allows for the production of high-quality, fresh produce, free from chemical pesticides and fertilizers, resulting in healthier and more nutritious food.

The fish raised in aquaponics systems, such as tilapia, catfish, or ornamental species, are nurtured in a balanced ecosystem that promotes their growth and health. The organic nature of the system, where waste nutrients from fish are converted into plant food, ensures that both fish and plants are free from harmful additives, leading to the production of pure, high-quality fish and vegetables.

iv). Environmental and Economic Benefits

Aquaponics not only offers water savings but also presents significant environmental benefits. The system minimizes water pollution, as the nutrient-rich water is reused within the system rather than being discharged into the environment. Additionally, the elimination of soil in the plant-growing process reduces the risk of soil-borne diseases and pests, decreasing the need for chemical interventions.

Economically, aquaponics systems can be cost-effective over time, despite potentially higher initial setup costs. The system's ability to produce both fish and vegetables year-round provides a consistent food supply, which can enhance food security and offer steady income streams for producers. The scalability of aquaponics also makes it suitable for various applications, from small-scale home systems to large commercial operations, further enhancing its appeal as a versatile agricultural method.

v). Promoting Aquaponics in Communities

The promotion of aquaponics as a water-efficient food production method involves educating communities about its benefits and providing the necessary training and resources to implement these systems. Demonstration projects, workshops, and hands-on training sessions can help farmers and urban gardeners understand the principles and practices of aquaponics, enabling them to adopt this sustainable technology effectively.

By showcasing the advantages of aquaponics, such as water conservation, efficient land use, and the production of organic, high-quality food, communities can be encouraged to integrate this method into their agricultural practices. This transition not only supports local food production but also contributes to broader environmental sustainability and resilience against climate change.

In summary, promoting aquaponics as a water-efficient method for producing high-quality food offers a practical solution to some of the pressing challenges in agriculture today. By leveraging the symbiotic relationships between fish and plants, aquaponics can significantly reduce water use, improve food security, and support sustainable livelihoods, making it a vital component of modern agricultural strategies.

- *Create a sustainable solution for growing and supplying locally grown organic, tasty and nutritious food. Aquaponics utilizes 90% less water than conventional farming.*

i). Establishing a Sustainable System for Organic, Nutritious Food Production

The objective of this initiative is to establish a sustainable system for the cultivation and supply of organic, nutritious food. By focusing on sustainable agricultural practices, the project aims to enhance food security and promote self-sufficiency within the community. This system is designed to provide a reliable source of fresh, healthy produce, while minimizing environmental impact and ensuring economic viability.

ii). Sustainable Agricultural Practices

At the heart of this initiative is the commitment to sustainable agriculture, which prioritizes ecological balance, resource conservation, and the health of both producers and consumers. The system employs methods such as organic farming, which avoids the use of synthetic fertilizers and pesticides, thereby preserving soil health and promoting biodiversity. Additionally, the integration of aquaponics—a combination of aquaculture and hydroponics ensures efficient water usage and nutrient recycling, making it a key component of this sustainable system.

iii). Organic and Nutritious Food Production

The production of organic food is central to this initiative. Organic farming methods enhance soil fertility through natural processes, such as composting and crop rotation, while protecting the ecosystem from harmful chemicals. The focus on organic practices ensures that the food produced is free from synthetic additives, offering consumers healthier and more nutritious options. This approach also supports the cultivation of a diverse range of crops, which contributes to a balanced diet and improves nutritional outcomes for the community.

In addition to plant-based foods, the system supports the production of organic fish through aquaponics. The fish provide a valuable source of protein, complementing the vegetables grown in the system. The symbiotic relationship between fish and plants in aquaponics not only maximizes the use of available resources but also enhances the overall nutritional value of the food produced.

iv). Enhancing Food Security

Food security is a critical goal of this project. By establishing a local, reliable source of organic food, the community can reduce its dependence on external food supplies, which are often subject to fluctuations in availability and price. The system's ability to produce food year-round further stabilizes food supply, ensuring consistent access to fresh, nutritious produce regardless of seasonal variations. This stability is particularly important in areas prone to food shortages or those facing economic challenges.

v). Promoting Self-Sufficiency

Beyond enhancing food security, the project aims to foster self-sufficiency within the community. By providing training and resources, the initiative empowers local farmers and residents to adopt sustainable farming practices and manage their own food production systems. This not only reduces the community's reliance on imported food but also builds local capacity for innovation and resilience in agriculture.

Self-sufficiency also extends to economic benefits. By producing food locally, the community can reduce transportation costs and the carbon footprint associated with long-distance food distribution. Moreover, the sale of surplus produce can generate income, further contributing to the community's economic stability and growth.

vi). Environmental and Economic Sustainability

The emphasis on sustainability encompasses both environmental and economic aspects. Environmentally, the system promotes practices that protect natural resources, such as water and soil, and support ecosystem health. The use of renewable resources and reduction of waste are key principles guiding the system's design and operation.

Economically, the system is designed to be cost-effective and scalable. Initial investments in infrastructure, such as aquaponics systems or organic farming setups, are balanced by the long-term savings from reduced input costs and the potential for income generation. This economic model ensures that the system can be maintained and expanded over time, benefiting current and future generations.

- *Aquaponics is an excellent way to sustainably grow fresh fish and vegetables for a family, to feed a village, or generate a profit in a commercial farming.*

i). Comprehensive Training and Demonstration of Eco-Friendly Aquaponics Technology

This project aims to provide comprehensive training and demonstration to the local population, promoting the adoption of eco-friendly aquaponics technology. By focusing on this innovative and sustainable agricultural practice, the initiative seeks to foster self-employment opportunities, generate income, and enhance nutritional outcomes for the community.

ii). Training and Knowledge Transfer

A key component of the project is the delivery of thorough training programs designed to equip participants with the knowledge and skills necessary to establish and manage aquaponics systems. These training sessions cover a range of topics, including the basics of aquaponics, system design and setup, water quality management, fish and plant selection, and nutrient cycling. By providing hands-on experience, participants gain practical insights into the day-to-day operations of an aquaponics system.

The training also emphasizes eco-friendly practices, teaching participants how to minimize environmental impacts through efficient resource use, waste management, and organic cultivation methods. This education empowers individuals to produce high-quality, organic food

while conserving water and reducing the need for chemical inputs.

iii). Demonstration and Practical Application

To facilitate learning, the project includes demonstration sites where trainees can observe fully operational aquaponics systems. These demonstration units serve as practical models, showcasing the integration of fish and plant production in a controlled environment. Trainees can witness firsthand the benefits of aquaponics, such as rapid plant growth, efficient water use, and the production of healthy fish and vegetables.

The demonstration sites also highlight the versatility and scalability of aquaponics technology, demonstrating how it can be adapted to various scales, from small household units to larger commercial setups. This exposure helps participants understand the potential applications of aquaponics in different contexts, whether for personal consumption, community gardens, or commercial ventures.

iv). Encouraging Adoption for Self-Employment and Income Generation

One of the primary goals of the training program is to encourage the adoption of aquaponics technology as a means of self-employment and income generation. By providing the necessary skills and resources, the project aims to empower individuals to start their own aquaponics businesses. This can range from producing fresh vegetables and fish for local markets to providing consultancy services for setting up aquaponics systems.

The potential for income generation through aquaponics is significant. As demand for organic and locally produced food grows, individuals who adopt this technology can tap into niche markets, offering high-quality, sustainable products. Moreover, aquaponics systems have relatively low ongoing costs once established, making them a cost-effective option for generating a steady income.

v). Improved Nutrition and Community Well-being

Beyond economic benefits, the adoption of aquaponics technology also has important implications for nutrition and community well-being. The ability to produce fresh, organic vegetables and fish locally enhances food security and ensures that community members have access to nutritious foods. This is particularly valuable in areas where fresh produce may be scarce or expensive.

By improving access to a diverse range of foods, including leafy greens, herbs, and high-quality fish, aquaponics systems contribute to a more balanced and healthy diet. This can lead to better health outcomes, reducing the prevalence of nutrition-related issues and enhancing overall community health.

vi). Building a Sustainable Future

The project's emphasis on eco-friendly practices and sustainable technology aligns with broader

environmental and economic sustainability goals. By training the local population in aquaponics, the project not only addresses immediate needs for food and income but also fosters a culture of sustainability and innovation. Participants learn to value and protect natural resources, ensuring that agricultural practices can be maintained for future generations.

- *To provide demonstration and training to beneficiaries for adoption of eco-friendly Aquaponics technology as an additional crop and generating self-employment, improving nutritional needs, livelihood and income generation among the people of Bhopal District.*

i). Facilitating Market Linkages and Ensuring Economic Viability of Aquaponics Systems

The successful implementation of aquaponics systems not only depends on effective production techniques but also on the ability to access and leverage market opportunities. This initiative is focused on facilitating market linkages and ensuring the economic viability of aquaponics systems for the local community. By connecting producers with markets, this project aims to create sustainable income streams, support local economies, and maximize the benefits of aquaponics for all stakeholders.

ii). Developing Market Linkages

To ensure the profitability and sustainability of aquaponics systems, it is crucial to establish robust market linkages. This project includes a strategic effort to connect aquaponics producers with various market channels, including local farmers' markets, grocery stores, restaurants, and direct-to-consumer sales. By identifying and engaging with these potential buyers, the project helps create a reliable demand for aquaponically produced goods.

Market linkage development involves several key activities, such as market research, outreach, and networking. Market research is conducted to understand consumer preferences, pricing strategies, and competitive dynamics. This information guides producers in tailoring their products to meet market needs and setting appropriate prices. Outreach and networking efforts involve building relationships with buyers and distributors, participating in local food events, and utilizing online platforms to reach a broader audience.

iii). Marketing Aquaponic Products

A crucial aspect of facilitating market linkages is the effective marketing of aquaponic products. The unique selling points of these products—such as being locally produced, organic, sustainable, and chemical-free—are emphasized in marketing campaigns. Educating consumers about the benefits of aquaponics, including its minimal environmental impact and the superior nutritional quality of its produce, helps differentiate these products in the marketplace.

Creating a strong brand identity for aquaponic products involves designing appealing packaging, developing informative labels, and leveraging social media and other digital marketing tools. Producers are also encouraged to participate in local fairs and exhibitions to showcase their products and engage directly with consumers, building trust and loyalty.

iv). Ensuring Economic Viability

For aquaponics systems to be economically viable, it is essential to optimize production efficiency and manage costs effectively. The project provides guidance on best practices for system management, including efficient water and energy use, disease control, and maximizing crop yields. Additionally, producers are trained in financial management, helping them track expenses, forecast revenues, and make informed decisions about scaling their operations.

Another component of economic viability is diversification. Producers are encouraged to diversify their product offerings, such as growing a variety of vegetables and herbs alongside fish, to cater to different market segments and reduce risk. Value-added products, such as pre-packaged salads or processed fish, can also enhance profitability.

v). Access to Financial Resources and Support

To support the establishment and growth of aquaponics enterprises, the project also facilitates access to financial resources. This includes providing information about grants, loans, and other funding opportunities available from government programs, non-governmental organizations, and private investors. Additionally, the project may offer financial literacy training, helping participants understand budgeting, investment, and savings strategies.

Collaborations with microfinance institutions or agricultural cooperatives can further provide community members with the capital needed to start or expand aquaponics systems. This financial support is crucial for overcoming initial investment barriers and sustaining operations through early stages of development.

vi). Long-term Sustainability and Community Impact

By fostering strong market linkages and ensuring the economic viability of aquaponics systems, the project aims to create long-term sustainability for local producers. This not only enhances the economic well-being of individual families but also contributes to the overall economic development of the community. Successful aquaponics businesses can become models for sustainable agriculture, inspiring others to adopt similar practices and contributing to a more resilient local food system.

Furthermore, the increased availability of fresh, organic produce improves local food security and public health. As the community benefits from higher-quality food and increased economic activity, the overall quality of life improves, fostering a stronger, more self-reliant community.

Objectives Achieved within the Two-Year Period.

Over the course of two years, the following objectives were successfully accomplished:

- **Productivity Enhancement:** The introduction of low-cost Aquaponics technology significantly improved the productivity of locally available resources. The project specifically focused on integrating *Pangasius-pangasius* and India Major Carps fish culture with the use of *Azolla-pinnata* as a natural fish feed.
- **Water Conservation:** The implementation of Aquaponics proved to be an effective

method for conserving water, allowing for the production of high-quality food while utilizing 90% less water compared to traditional farming methods.

- **Sustainable Agriculture:** A sustainable system was established for growing and providing locally sourced organic, nutritious, and delicious food. This system not only reduced water usage but also ensured a continuous supply of organic produce.
- **Versatility of Aquaponics:** The versatility of Aquaponics was demonstrated, showcasing its suitability for growing fresh fish and vegetables. The system proved effective for personal use, community nourishment, and commercial farming, providing a sustainable food source and potential profit.
- **Training and Demonstration:** Comprehensive demonstrations and training sessions were provided to local beneficiaries. This initiative promoted the adoption of eco-friendly Aquaponics technology as an additional income-generating activity. It also contributed to improving self-employment opportunities, nutritional intake, livelihoods, and income generation for the people of Bhopal District, Madhya Pradesh.

Through these achievements, the project successfully addressed key challenges and met its stated goals, benefiting both the local community and the environment.

Training program of Aquaponics unit at Bilkhiriya village:





Training program of Aquaponics unit at Bilkhiriya village:





Raft System of Aquaponics unit at Bilkhiriya village (ponds).

Training program of Aquaponics unit at Bilkhiriya village.





Students from *Govt. Maharani Laxmi Bai Girls College, Bhopal*, visited the aquaponics facility at Bilkhiriya village for educational exposure and practical learning.





We thank students from **MANIT, Barkatullah University, and Govt, MLB Girls College, Bhopal**. Around **75** students visited the aquaponics facility, enhancing educational collaboration.





Training program of Aquaponics unit at Bilkhiriya village.

Training program of Aquaponics unit with Solar system at Sankal village.





Training program of Aquaponics unit fish feeding at Bilkhiriya village.

Training program of Aquaponics unit fish feeding at Bilkhiriya and Sankal village.



Training program of Aquaponics unit at Sankal village.





Refresher training and workshop at Sankal village.







Training program of Raft and Vertical Farming at Bilkhiriya village.

Strawerry plantation at village Bilkhiriya Aquaponics unit.



Strawerry crop cultivation at village Bilkhiriya Aquaponics unit.





Fish crop cultivation at village Bilkhiriya Aquaponics unit.

Aquaponics unit at Bangrasiya village.



Aquaponics unit at Bagroda village.

Aquaponics unit (NFT System) at Sankal village.



Aquaponics unit (NFT System) at Sankal village.





Aquaponics unit at Sankal village.



Cauliflower crop at Sankal village.



NFT, System of Aquaponics System at Bagroda village.

Raft System of Aquaponics System at Bagroda village.



NFT, System of Aquaponics System at Bilkhiriya village.



Cucumber and Tomato crops at Sankal village, Bhopal.

Brinjal crops at Bangrasiya village, Bhopal.



Refresher training and workshop at Bangrasiya village.



Aquaponics unit at Bagroda village, Bhopal.



Aquaponics unit at Bagroda village, Bhopal.





Refresher training and workshop at Bilkhiriya and Bagroda village.

Aquaponics unit fish seed stocking at Bagroda village Bhopal.



The NABARD DDM visited the aquaponics unit at Bagroda, Bangrasiya & Sankal village.

6. Project Area and Target Population:

i). Project Location and Implementation in Phanda Block, Bhopal: The aquaponics project was successfully implemented across four villages in the Phanda Block of Bhopal District, Madhya Pradesh: *Bilkhiriya, Sankal Tanda, Bangrasiya and Bagroda*. These villages were strategically selected for their unique agricultural potential and the community's openness to adopting innovative farming techniques. Currently, the project boasts four fully operational aquaponics units, which are actively producing both fish and a variety of vegetables, marking a significant achievement in sustainable agriculture for the region.

ii). Site Selection and Setup: Each of the four villages offered a distinct environment conducive to the establishment of aquaponics systems. The selection process involved careful consideration of factors such as water availability, community interest, and logistical feasibility. With the support of local leaders and the participation of community members, the project team established aquaponics units in each village. These systems are designed to be efficient, scalable, and adaptable to local conditions, utilizing available resources effectively. The aquaponics units combine fish tanks with hydroponic plant beds, creating a closed-loop system where fish waste provides essential nutrients for plant growth. In return, the plants help purify the water, which is then recirculated back to the fish tanks. This sustainable approach not only conserves water but also enhances the production of organic, chemical-free vegetables and healthy fish, making it an ideal solution for areas facing water scarcity and soil degradation.

iii). Land Use: The aquaponics project was successfully implemented in four villages of Phanda Block, Bhopal District: *Bilkhiriya, Sankal Tanda, Bangrasiya, and Bagroda*. Land for the systems was secured through a combination of panchayat leases, private rentals, and land owned by SHGs/FPOs and individual SHG members. This flexible approach allowed efficient setup, leveraging communal and private resources. The project fostered community ownership and ensured sustainable use of local land for aquaponics, addressing water scarcity and soil degradation. The initiative has strengthened local livelihoods by producing chemical-free vegetables and healthy fish, contributing to food security in the region.

iv). Preliminary Survey of Aquaponics System:

A survey of aquaponics units was conducted in four villages within the Phanda Block of Bhopal district. Four aquaponics systems were surveyed, and water samples were collected for further analysis. The water quality data from four aquaponics units in the Phanda Block of Bhopal district are provided below:

Parameter	Aquaponic unit Bilkhiriya (1)	Aquaponic unit Sankal (2)	Aquaponic unit Bangrasiya (3)	Aquaponic unit Bagroda (4)
Air temperature	34	33	33	33
Water temperature (°C)	30.29	30	30	29
pH	7.5	7.2	8	7.5
Conductivity (us/cm)	230	180	220	210
Dissolved oxygen (mg/l)	6.8	6.6	6.7	6.8
Total Alkalinity (mg/l)	120	110	105	115

v). Current Operation and Output:

As of now, all four aquaponics units are in excellent working condition and are actively producing. The systems have been populated with fish species such as *Pangasius-pangasius* and Indian Major Carps, including Rohu, Catla, and Mrigal. These fish were selected for their hardiness and compatibility with the local climate, as well as their market value. The plants grown in these units include a variety of leafy greens, herbs, and vegetables such as lettuce, basil, spinach, tomatoes, and peppers. These crops were chosen for their nutritional value and their adaptability to the aquaponic environment.

The yield from these aquaponics units has been encouraging, with consistent production of both fish and vegetables. The produce has not only met the dietary needs of the local community but has also begun to generate surplus, providing opportunities for sale in local markets. This surplus production supports the economic viability of the aquaponics units, offering an additional income source for the community members involved in their operation. Each Self-Help Group (SHGs) is expected to receive a tentative benefit of Rs. 1,15,100/- with each beneficiary receiving approximately Rs. 4,604/- per year.

vi). Community Involvement and Benefits:

The implementation of these aquaponics systems has been a collaborative effort, with substantial involvement from local residents. Community members received training in system maintenance, fish and plant care, and harvesting techniques. This hands-on experience has empowered them to manage the units independently, fostering a sense of ownership and pride in the project. Moreover, the initiative has provided valuable skills that can be transferred to other agricultural or business ventures.

The benefits of these aquaponics units extend beyond food production. They serve as educational hubs, demonstrating sustainable farming practices and the potential for innovative agriculture in rural settings. The project has also created job opportunities and encouraged the local economy through the sale of surplus produce. As a result, the community is experiencing improved food security, better nutrition, and increased economic stability.

vii). Future Prospects:

Looking ahead, the success of these initial aquaponics units lays a strong foundation for potential expansion. There is significant interest in replicating this model in other villages and scaling up existing units to increase output. With ongoing support and continued community engagement, the project aims to further enhance the resilience and self-sufficiency of the local food system, while also serving as a model for sustainable agricultural practices in similar regions.

In conclusion, the aquaponics project in the villages of Bilkhiriya, Sankal Tanda, Bangrasiya, and Bagroda has made notable strides in promoting sustainable agriculture, improving local nutrition, and providing economic opportunities. The fully operational units stand as a testament to the viability and benefits of aquaponics, offering a promising pathway towards a more sustainable and prosperous future for the region.

viii). Target Population and Training Initiatives: The aquaponics project aimed to empower and uplift the local population in the villages of Bilkhiriya, Sankal Tanda, Bangrasiya, and Bagroda by targeting 100 beneficiaries through Self-Help Groups (SHGs). Each SHG comprised 25 members, collectively forming a diverse group of individuals including farmers, unemployed youth, and other community members eager to explore aquaponics as a viable alternative livelihood. This inclusive approach ensured that a broad spectrum of the community could benefit from the project's training and resources.

ix). Engagement with Self-Help Groups:

The project strategically engaged with four SHGs, recognizing these groups as effective platforms for community development and economic empowerment. Each SHG was carefully selected based on their interest in sustainable aquaculture, agriculture and their potential to benefit from aquaponics technology. The members of these groups were introduced to the concept of aquaponics, a system that integrates aquaculture (fish farming) with hydroponics (soilless plant cultivation), highlighting its advantages in water conservation, organic food production, and sustainable farming practices.

x). Field Demonstration and Comprehensive Training Programs:

Field Demonstration and Training Activities The training will cover both Aquaponics and Hydroponic farming systems.

The training course includes:

- Basics of Agriculture
- Greenhouse Construction
- Organic Farming
- Hydroponics
- Aquaponics
- Aquaponics NFT (Nutrient Film Technique) Farming
- Aquaponics Raft Farming
- Aquaponics Vertical Farming
- Integrated Pest Management
- Automation Demonstration
- Building Your Own Aquaponic Farming System

Details of the Training Program:

a. **Aquaponics Class (2-Day):** This class combines face-to-face lessons with hands-on training in a greenhouse, conducted over two days. It is designed for participants to directly engage with and understand the practical aspects of Aquaponics.

b. **Low-Cost Equipment Setup:** Participants will learn how to create their own low-cost fish tanks, grow beds, sumps, and filter tanks.

c. **System Operation and Troubleshooting:** The training will cover the entire process, including

stocking fish seeds, their rearing and harvesting, as well as the growth and harvesting of plants.

d. Farm Visit and Practical Demonstrations: The training includes a visit to a small aquaponic farm, with practical demonstrations of germination, transplantation, and the construction of several Hydroponic setups.

e. Hands-On Training: The field demonstrations and training activities will be highly practical, allowing participants to perform various operations related to integrated Aquaponic crop production. Experts from relevant fields will be invited to provide training on different aspects of the process.

To equip the beneficiaries with the necessary skills and knowledge, the project facilitated 42 comprehensive training sessions including two refresher training sessions, across four villages. These sessions covered all aspects of setting up and managing aquaponics systems, including the basics of aquaculture and hydroponics, system design and maintenance, water quality management, and the care and harvesting of both fish and plants. The training also emphasized sustainable practices, such as organic farming techniques and resource efficiency, ensuring that the participants could implement environmentally friendly and cost-effective systems.

Each training session was tailored to meet the specific needs and skill levels of the participants, providing both theoretical knowledge and practical, hands-on experience. Demonstration units were established in each village, serving as live examples where participants could observe and practice the operation of aquaponics systems. This experiential learning approach helped demystify the technology and allowed beneficiaries to confidently engage with the systems.

Training: The Society for Environmental Conservation conducted **42** training sessions, including **40** comprehensive training sessions, **2** refresher training sessions and workshops, on the integrated aquaponics system. The training focused on using *Azolla pinnata* and periphyton as a natural feed for fish culture in this project. All aspects of the integrated aquaponics system were covered in these sessions, as outlined below:

Sl. No.	Date of training Start	Date of training Completed	Place of training at village	Number of training
1.	24/01/2023	27/01/2023 (2 training)	Bilkhiriya	2
2.	26/02/2023	27/02/2023 (1 training)	Bilkhiriya	1
3.	27/03/2023	30/03/2023 (2 training)	Bilkhiriya	2
4.	22/05/2023	31/05/2023 (5 training)	Bilkhiriya	5
5.	27/06/2023	30/06/2023 (2 Refresher training & workshop for four SHGs)	Bilkhiriya, Sankal, Bagroda & Bangrasiya village.	2
6.	20/07/2023	31/07/2023 (6 training)	Sankal	6
7.	28/08/2023	04/09/2023 (4 training)	Sankal	4
8.	29/09/2023	06/10/2023 ((4 training)	Bangrasiya (Place Sankal)	4
9.	01/11/2023	12/11/2023 (6 training)	Bangrasiya (Place Sankal)	6
10.	23/11/2023	08/12/2023 (8 training)	Bagroda (Place Bangrasiya)	8
11.	28/01/2024	31/01/2024 (2 training) (Aquaculture & hydroponics)	Bagroda (Place Bangrasiya)	2
			Total	42 training completed.

xi). Focus on Diverse Beneficiaries:

The project specifically targeted farmers looking to diversify their income sources, unemployed youth seeking new career opportunities, and other community members interested in sustainable agricultural practices. By involving these groups, the project aimed to address various social and economic challenges, such as unemployment and food insecurity. Farmers, in particular, benefited from learning a new method of farming that requires less water and land compared to traditional agriculture, offering them a sustainable alternative in the face of changing environmental conditions.

Unemployed youth were provided with a unique opportunity to gain valuable skills in a growing field, opening up new avenues for employment and entrepreneurship. The training empowered these young individuals to start their own aquaponics ventures, potentially leading to job creation and economic growth within their communities. Other community members, including women and marginalized groups, were also included, ensuring broad-based participation and equitable access to the project's benefits.

xii). Outcomes and Community Impact:

The training and support provided to the SHGs resulted in a well-prepared cohort of aquaponics practitioners. These newly trained individuals are now capable of managing their aquaponics systems, contributing to local food production, and generating income through the sale of fish and vegetables. The project's impact extends beyond the immediate economic benefits; it also fosters a culture of innovation and sustainability in the community.

The initiative has led to increased awareness of sustainable agriculture and the potential of aquaponics to improve livelihoods. The successful implementation of the systems in these villages serves as a model for other communities, encouraging wider adoption of this technology. Furthermore, the project's focus on training and capacity building has strengthened community cohesion and resilience, as members work together towards a common goal of sustainable development.

xiii). Challenges and the Role of Aquaponics in Addressing Water Scarcity:

The region encompassing the villages of Bilkhiriya, Sankal Tanda, Bangrasiya, and Bagroda in the Phanda Block of Bhopal District, Madhya Pradesh, faces significant challenges related to water scarcity. This issue is particularly pronounced during the summer months when water availability dramatically decreases, exacerbating difficulties in agriculture and daily living. The lack of reliable primary water sources further compounds these problems, often leading to seasonal migration as community members seek employment opportunities elsewhere to sustain their livelihoods.

xiv). Water Scarcity and Agricultural Challenges:

Water scarcity in the region is a critical concern, with the dry season severely limiting the

availability of water for irrigation and household use. Traditional farming methods, which typically rely on extensive water use, become unsustainable during these periods, resulting in reduced crop yields and food insecurity. The inadequate water supply also affects livestock, leading to further economic strain on farming households. As a consequence, many residents are compelled to migrate to urban areas in search of work, disrupting community cohesion and placing additional stress on already limited urban resources.

The problem is compounded by the region's reliance on seasonal rainfall, which is increasingly unpredictable due to climate change. The absence of sufficient water storage infrastructure exacerbates the situation, leaving communities vulnerable during droughts. The seasonal nature of agriculture, combined with water scarcity, means that income from farming is often irregular and insufficient, pushing many households into economic instability.

xv). Aquaponics as a Sustainable Solution:

The introduction of aquaponics in these villages aimed to address the water scarcity challenge by providing a sustainable and water-efficient agricultural practice. Aquaponics systems utilize a closed-loop cycle that significantly reduces water usage compared to traditional farming methods. In this system, water is recirculated between fish tanks and plant beds, with fish waste providing nutrients for plant growth and plants helping to purify the water. This efficient use of water makes aquaponics an ideal solution for regions with limited water availability.

By adopting aquaponics, farmers can grow a variety of crops, including vegetables and herbs, alongside fish, thus maximizing the productivity of the available water. This system not only conserves water but also eliminates the need for chemical fertilizers, as the nutrient-rich fish waste naturally supports plant growth. The reduced water requirement and minimal reliance on external inputs make aquaponics a cost-effective and environmentally friendly agricultural practice.

xvi). Integration of aquaculture (Additional Agricultural and Aquaculture):

Integrated fish farming is a well-established agricultural system that creates a sequential linkage between two or more farming activities to optimize crop production. It is a key component of sustainable agriculture, where fish serve as a primary commodity for improving livelihoods and combating malnutrition. Enhancing fish production through integrated aquaculture utilizing *azolla* and periphyton as natural food sources alongside livestock and crop farming significantly improves resource efficiency. This technique involves recycling agricultural waste and byproducts from one farming system as inputs for another, ensuring the efficient use of available farming space for maximum productivity.

Adopted Activities (Additional Pond-Based Farming on Embankments and Open Land):

The implementation of this system was achieved through the development of the following activities:

(1) Paddy cum fish system: Types of paddy/rice field for preparation method of the rice plot usually vary according to the land contours and topography, under present study following types

were adopted.

(a) **Perimeter type;** The paddy/rice growing area was placed at the middle with moderate elevation and ground sloping on all sides into perimeter trenches to facilitate easy drainage.

(b) **Central pond type;** Paddy/Rice growing area was on the fringe with slopes towards the middle.

(c) **Lateral trench type;** Trenches was prepared on one or both lateral sides of the moderately sloping rice field.

Paddy cum fish system: The Paddy/ rice fields and small fish ponds constructed under the project served as fish (seed rearing) nurseries to grow fries into fingerlings (within 60-90 days) for further stock in production ponds to obtaining high fish yields. It is only a co-activity of agricultural operation, in which the drained-out water from the paddy farming was prudentially utilized for fish farming. The introduction of the fish culture in paddy cultivation enhanced the labour absorption potentials of rural community, during post-harvesting and marketing. Under the present activity major carps like Catla (*Catla catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus mrigala*) as well as Common carp (*Cyprinus carpio*); Silver carp (*Hypophthalmichthys molitrix*) and Grass carp (*Ctenopharyngodon idela*) were grown in the paddy fields by developing *azolla* and periphyton using agriculture refuse like paddy straw (puaal), poultry waste and manuring with cow dung, cow urine etc. with designated quantity and quality. Paddy fields served as fish nurseries to grow fries into fingerlings. The fingerlings thus, produced in large quantities, were stocked in production ponds for obtaining better fish yield under composite fish culture. Thus, fingerlings were stocked in production ponds for obtaining high fish yields. The stocking density was of six-species combination in the following ratio:

- Catla and silver carp 30-35%
- Rohu and Mrigal 15-20%
- Common carp 45% and Grass carp 5-10%.

(2) **Pond cum-fish system:** Pond Preparation method helped in:

(a) **Pond draining:** To collect and eliminate old stocks, predators and unwanted species.

(b) **Pond washing:** To remove the effect of toxic chemicals when insecticides were used.

(c) **Leveling of pond bottom:** Removes excess mud and dirt, ensure complete drainage and facilitate ease of seining during harvesting.

(d) **Sun drying:** Helps eliminate and evaporates toxic gases and ammonia especially in old ponds.

(e) **Liming:** The rate of application is 100 g/m² or 1,000 kg/ha.

(f) **Screening of water inlet and outlet:** Screening of water inlet and outlet- Prevent entrance of unwanted species and escape of stocks.

(g) **Water filling:** Fill the pond with water to about 1.5 m to 2 m deep, to provide a wide environment for the fish.

(h) **Basal fertilization:** Basal fertilization should be done with the application of organic manure (e.g. poultry manure, also known as complete fertilizer) as well as inorganic fertilizer. The application of poultry manure was done at weekly intervals @ 50 Kg/hectare and while decomposed cow dung @ 4500 kg/hectare, urea @ 100 kg/ hectare, and Triple Super Phosphate @ 100 kg/ hectare at fortnightly intervals.

Pond culture: After attaining a size of 80 mm, the fingerlings (approx.) were transferred to culture pond. During composite fish culture, six different types of fish species were grown together in the single fishpond. Fish with different food habitats were selected so they don't fight with each other for food. This technology involved, the eradication of aquatic weeds and predatory fishes, insects and live fish food organisms. The stocking of fingerlings and rearing were done for 6-7 months. Stocking density of six-species was of following ratio/combination:

- Catla and silver carp 30-35%
- Rohu and Mrigal 15-20%
- Common carp 45% and Grass carp 5-10%.

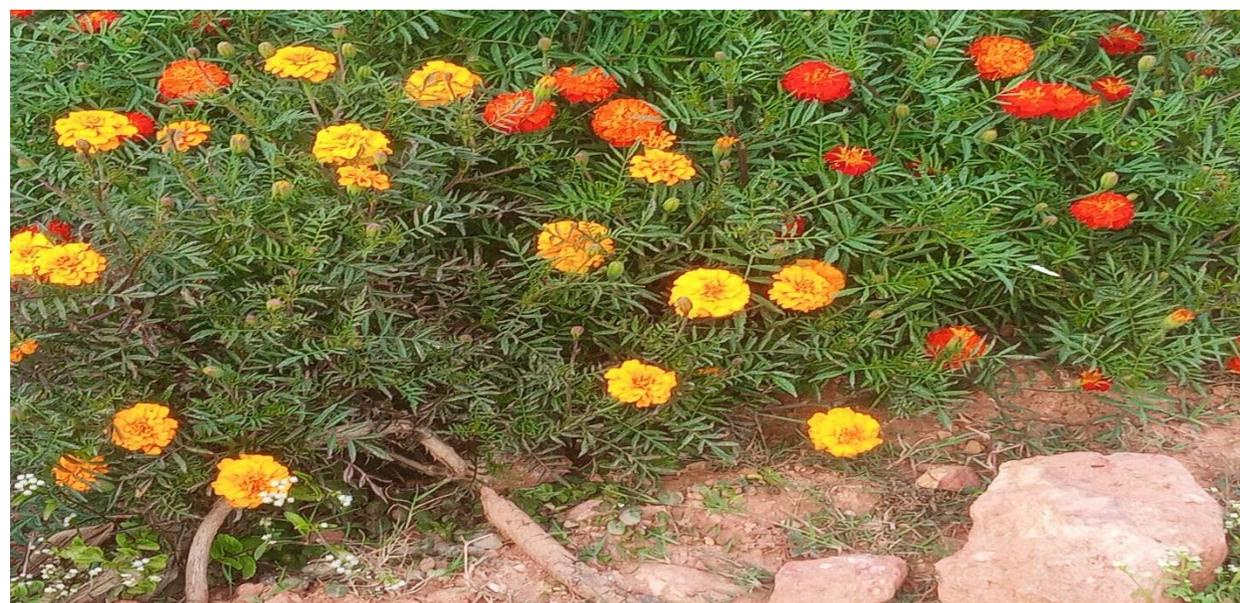
A fish production between 3,000 to 6,000 Kg. per hectare per year were achieved through present composite fish culture system.

(3) Wheat Crop Cultivation:

This technique involves the efficient recycling of agricultural waste and byproducts, ensuring that resources from one farming system are effectively utilized in another. By integrating wheat cultivation with pond cum-fish farming, available farming space is optimized, leading to increased productivity and sustainability.

(4) Horticulture and Floriculture:

Horticulture and floriculture activities, including the cultivation of bananas, roses, and marigolds, were carried out in designated village ponds as part of an integrated aquaculture system. Agricultural waste such as paddy and wheat straw, cattle dung, and urine was utilized to support plant growth. Indian Major Carp's (IMC) like rohu, catla, mrigal and exotic carp were cultivated in the identified village ponds using the agriculture refuse like paddy straw, cattle faecal matter and urine etc. At the same time dykes of the paddy/rice fields and ponds were utilized for growing horticulture crops like Banana, Papaya etc. and vegetables like Tomato, Potato, Brinjal, Chili, Cucumber, Sponge Gourd (Gilki Turai) Been and Fruits.





Floriculture at Sankal village.



(5) Livestock-Cum-Fish System:

Villagers were trained in livestock farming, including cattle, poultry, and goats. Poultry manure, cow dung, urine, and other organic waste were used to enhance periphyton production in paddy fields and ponds. This agriculture-based integrated system provided multiple benefits, including the production of milk, meat, eggs, fruits, vegetables, flowers, and paddy, along with fish.

(a) Cow and Cattle-Cum-Fish System: Raw cattle dung was used to fertilize fish ponds, while the humus from these ponds was utilized for growing cattle fodder. Among all livestock waste, cow dung was the most abundant. A unit of 5–6 cows provided sufficient manure for 1 hectare of pond.

(b) Poultry-Cum-Fish System: A simple and economically viable fish-cum-poultry farming system was developed, where poultry droppings from fully built-up poultry litter were recycled into fish ponds, enhancing nutrient availability for fish growth.

(c) Goat-Cum-Fish System: Goats, often referred to as the "poor man's cow," have traditionally been farmed for meat, milk, and manure. Their waste was efficiently utilized to enrich fish ponds, contributing to a sustainable integrated farming system. Integrated farming is practiced in the villages of Bilkhiriya, Sankal, Bangrasiya, and Bagroda (Financial Assistance by **NABARD**).



Livestock-Cum-Fish System.

Financial Assistance (by PNB, Bilkhiriya Branch) and Implementation:

We sincerely appreciate the financial support provided by Punjab National Bank (PNB), Bilkhiriya Branch, Bhopal, for three women Self-Help Groups (SHGs):

1. Krishna Ajivika Swa Sahayta Samooh
2. Khushi Ajivika Swa Sahayta Samooh
3. Shree Ram Swa Sahayta Samooh

Through this initiative, 32 individuals have received loans to implement aquaponic systems, enabling the cultivation of exotic vegetables such as broccoli, cherry tomatoes, red and yellow bell peppers, and French beans, thereby enhancing agricultural diversity and economic opportunities.

We extend our gratitude to the students from Maulana Azad National Institute of Technology (MANIT) and other institutions, including Barkatullah University and Government Maharani Laxmibai Girls College, Bhopal. Approximately 75 students visited the aquaponic facility for educational exposure and practical learning, enriching academic collaboration.

The completion of three aquaponic units and the successful adoption of this technology have resulted in a total of seven fully operational units, underscoring the dedication of all stakeholders in promoting sustainable agricultural practices.



(The NABARD DDM, Bhopal visited the aquaponics unit at Bilkhiriya village).

xvii). Mitigating Seasonal Migration:

The implementation of aquaponics systems has the potential to significantly reduce the need for seasonal migration. By providing a reliable source of food and income, even during periods of water scarcity, aquaponics offers a stable livelihood option for community members. The continuous production of fish and vegetables ensures that households have access to nutritious food year-round, alleviating food insecurity. Moreover, the surplus produce can be sold in local markets, generating consistent income and reducing the economic pressures that drive migration.

The project has also created local employment opportunities, particularly for the youth and women, who are often disproportionately affected by migration. By staying in their villages, individuals can maintain social and family ties, contributing to stronger and more resilient communities. The skills and knowledge gained through training in aquaponics further empower residents, enhancing their capacity to adapt to changing environmental conditions and economic challenges.

xviii). Community Empowerment and Future Prospects:

The shift towards aquaponics not only addresses immediate water and economic challenges but also promotes long-term sustainability and community empowerment. As community members become more self-sufficient and less reliant on external water sources and markets, they gain greater control over their livelihoods and future. This empowerment fosters a culture of innovation and resilience, encouraging further exploration of sustainable practices and technologies.

Looking forward, the success of aquaponics in these villages could serve as a model for other water-scarce regions. By demonstrating the viability of this technology, the project has the potential to inspire wider adoption, contributing to regional and national efforts to address water scarcity and enhance food security.

7. Outcomes and Achievements:

Productivity and Resource Utilization:

- The introduction of aquaponics led to a significant increase in agricultural productivity, with a notable reduction in water usage (up to 90% less compared to traditional farming).
- *Azolla pinnata* and periphyton proved to be an effective natural food source for Indian Major Carp, Exotic carp, Murrel (*Channa marulius*) and *Pangasius-pangasius*, promoting sustainable fish farming.

Environmental Impact:

- The project demonstrated the viability of aquaponics as a sustainable agricultural practice, reducing water usage and chemical inputs.
- It contributed to biodiversity conservation by promoting the use of native species and organic farming practices.

Socio-Economic Impact:

- The project provided a stable income source for 100 beneficiaries, reducing migration and improving local economic conditions.
- Training and skill development enabled participants to start their own aquaponics systems, fostering entrepreneurship and self-employment.

Marketing and Sales:

- **Marketing Channels:**

The project established various marketing channels for selling fish and vegetable produce. Local fish markets were utilized for the sale of fish, while vegetables were marketed through existing commercial platforms, including the Ajeevika project. These channels provided a structured and reliable means for beneficiaries to reach customers and sell their products.

- **Self-Help Groups (SHGs):**

Beneficiaries were encouraged to form Self-Help Groups to enhance their market access and receive collective support. SHGs, offer numerous advantages, such as better bargaining power, access to larger markets, and the ability to negotiate better prices for their products. By organizing into SHGs, the participants could more effectively manage production, marketing, and sales, thereby increasing their profitability and sustainability.

- **Organic Vegetable Sales:**

The organic vegetables produced through the aquaponics systems were sold at weekly open markets, specifically designated for organic growers. One such market is located at Gandhi Bhawan in Shyamla Hills, Bhopal, Madhya Pradesh. This market provides an accessible platform for selling organic products, allowing growers to easily sell their produce to consumers interested in organic and sustainably-grown food. The presence of these specialized markets helps ensure that the organic produce reaches a dedicated consumer base, supporting both the financial sustainability of the project and the promotion of healthy, organic food options in the community.

- **Organic and Live Fish Fingerling seeds Sales:**

Organic and live fingerling fish seeds, as well as live fish, are available for sale from our aquaponics system or directly to fish farmers or costumer.

Production per unit through Aquaponics system and Integrated Aquaculture:

S. N.	Particulars	Amount/Quantity
1	Culture period fish fry 2 months for each crop	Total 5 crops in per year
2	Fish fry stocked	14,000 number in each crop
3	Expected Survival	50%
4	Total Fish survived (nos.)	7000 nos.
5	Average harvested fishes	7000 nos.
6	Expected Production (per piece/crop)	7000 fingerlings x 5 crops= 35000 (fingerlings)
7	Total Production per year (5 crops)	7000 x 5 crops = 35000 x 5 = Rs. 1,75,000/-
8	Sale price of live fingerlings fish	Rs. 5/- per piece of fingerlings
	Gross Income Per Year (Rs)	
	From fish (35000 x Rs. 5/-)	Rs. 1,75,000/-
	From Vegetables (1222 kg. x Rs. 45)	Rs.55,000/-
	From Plant tray sale (100 tray x @ Rs, 300)	Rs.30,000/-
	Total Income from Aquaponics unit	2,60,000/-

Additional Agricultural and Aquaculture-Based Income:

S. N	Particulars	Production & Rate	Total Amount
1	Fish production from pond (Pond-based farming on embankments and open land)	20,000 fish x Rs. 150 per kg.	3,00,000/-
2	Paddy crop cultivation	15 quintals x Rs. 3,400 per quintal	51,000/-
3	Wheat crop cultivation	20 quintals x Rs. 2,400 per quintal	48,000/-
4	Bean (Legume) or Dolichos crop	25 quintals x Rs. 4,000 per quintal	1,00,000/-
5	Horticulture and Floriculture: Marigold flower farming	5 quintals x Rs. 4,000 per quintal	20,000/-
6	Fruit-bearing trees (Banana, Papaya)	6 quintals x Rs. 4,000 per quintal	24,000/-
7	Poultry Farming System: Egg production from 10 hens annually	2,500–3,000 eggs @ Rs. 10 per egg	30,000/-

8	Chicken sales from 10 hens annually	10 x Rs. 1,500 per chicken	15,000/-
9	Cattle Farming System: Milk production from 5-6 cows	5,000 kg per year x Rs. 50 per kg.	2,50,000/-
10	Goat Farming System: 10 goats producing 20 kids per year	20 x Rs. 2,500 per kid	50,000/-
	Total Income from Pond		8,88,000/-

Total Annual Income:

Rs. 2,60,000 (from aquaponics system) + 3,00,000 + 51,000 + 48,000 + 1,00,000 + 20,000 + 24,000 + 30,000 + 15,000 + 2,50,000 + 50,000 = **Rs. 8,88,000/-** (from integrated aquaculture system) = 2,60,000 + 8,88,000 = **Rs. 11,48,000/-**.

Net Profit Calculation (Rs): Total Revenue - Operational Cost = Net Profit

- **Total Revenue: Rs. 11,48,000/-**
- Operational Cost (Aquaponics system & Integrated Aquaculture): **Rs. 4,50,000/-**
- **Net Annual Profit: Rs. 6,98,000/-**

Annual Net Profit per Self-Help Group (SHG): *Each Self-Help Group (SHG) is estimated to earn an annual profit of approximately Rs. 6,98,000/-.*

8. Future Prospects and Sustainability:

The project demonstrated the viability of aquaponics as a self-sustaining and integration of aquaculture enhancement as well as agricultural model. The trained beneficiaries are now equipped to independently manage and expand their aquaponic setups, ensuring continuous income generation and livelihood generation. The formation of SHGs provides a structured approach to marketing and scaling operations, promising long-term sustainability.

9. Challenges and Lessons Learned:

Challenges:

- Initial skepticism and resistance to adopting new technology were significant barriers.
- Technical challenges in setting up and maintaining aquaponics systems, particularly in managing water quality and system components.

Lessons Learned:

- Continuous community engagement and practical demonstrations are crucial for overcoming resistance to new technologies.
- Providing comprehensive training and support, including troubleshooting assistance, is essential for the successful adoption of aquaponics systems and integration of aquaculture.

10. Project Implementation and Phases:

Phase I: Initial Setup and Mobilization (3 Months)

This phase involved the foundational activities necessary for the project's success:

- **Community Interaction and Income Generation Program:** Initial meetings and workshops were conducted to introduce the concept of aquaponics and its potential benefits. The focus was on engaging the community and explaining the project's objectives.
- **Procurement and Setup:** Essential materials and equipment for aquaponics demonstrations and training were procured. Infrastructure setup, including greenhouses and training centers, was completed.
- **Mobilization and Group Discussions:** Efforts were made to mobilize the target population through group discussions, highlighting the benefits of aquaponics and encouraging participation.

Phase II: Demonstration and Training Activities (18 Months)

This phase focused on hands-on training and practical demonstrations:

- **Training Sessions:** A comprehensive training curriculum was developed, covering basics of agriculture, greenhouse construction, organic farming, hydroponics, and various aquaponic farming techniques such as NFT (Nutrient Film Technique), raft, and vertical farming.
- **Practical Demonstrations:** Beneficiaries were given hands-on experience in setting up and maintaining aquaponics systems, including fish tank construction, plant growing, and system troubleshooting.
- **Field Visits:** Participants visited existing aquaponics farms for practical exposure, enhancing their understanding and confidence in adopting the technology.
- **Market Linkages:** Training included strategies for marketing fish and vegetables, with a focus on local markets and potential commercial platforms.

Phase III: Process Documentation and Report Submission (3 Months)

The final phase involved:

- **Process Documentation:** Detailed records of all activities, challenges, and outcomes were maintained. This documentation was crucial for assessing project impact and future planning.

Report Submission: A comprehensive report, summarizing the project's progress, achievements, and challenges, was prepared and submitted to relevant stakeholders.

11. Conclusion and Future Recommendations:

The project successfully demonstrated the potential of aquaponics as a sustainable livelihood option in the Phanda Block of Bhopal District. The integration of *Azolla pinnata* and *periphyton* as a natural food source and the use of low-cost aquaponics systems and integration of aquaculture significantly improved local food security and economic stability. Future efforts should focus on

expanding the reach of the project, enhancing market linkages, and providing ongoing support and training to ensure the long-term sustainability of aquaponics systems and integration of aquaculture.

Future Recommendations:

- Expansion of training programs to cover more villages and beneficiaries.
- Development of advanced training modules on system optimization and advanced aquaponics techniques.
- Strengthening market linkages and exploring export opportunities for high-quality aquaponics and integration of aquaculture produce.

12. Acknowledgments:

The Society for Environmental Conservation (SEC) extends gratitude to all stakeholders, participants, and partners who contributed to the project's success. Special thanks to Dr. Brijesh Sharma, Mr. Aman Sharma, and the dedicated team members for their unwavering commitment and expertise.

Project Report Submitted by:

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List of beneficiaries from the aquaponics unit for the Self-Help Groups (SHGs) in Bilkhiriya village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name/Husband Name	Adhaar No.	Phone/ Mobile Number
1	Mukesh Mehra	Shri Raju Mehra	7829 5176 9753	6232756503
2	Smt. Rani Mehra	Shri Mukesh Mehra	6423 9061 7244	6232756503
3	Sanjay Gurjar	Ravi Gurjar	2036 6065 1892	7000547929
4	Ravindra Gurjar	Daulat Singh	6593 9777 8109	7000547929
5	Ravi Kushwaha	Seva Ram Kushwaha	5706 7394 8438	8269510718
6	Ravi Gurjar	Mishri Lal	6808 4937 7169	9009774773
7	Nikita Gurjar	Mishri Lal	9752 0779 4816	9009774773
8	Abhisek Lodhi	Dashrath Lodhi	7202 1646 1619	9754457364
9	Deepak Lodhi	Dashrath Lodhi	2455 8604 3508	9754457364
10	Smt. Geeta Lodhi	Dashrath Lodhi	8914 1987 7528	9754457364
11	Ku. Jyoti Lodhi	Dashrath Lodhi	2962 0879 2258	9754457364
12	Divya Pal	Babu Lal Pal	4906 5140 1824	6232756503
13	Bhupendra Pal	Lakshmi Narayan Pal	2805 1874 7846	6232756503
14	Mandeep Kaur	Satpal Singh	4403 0648 1985	8269510718
15	Amrit Singh	Satpal Singh	2633 2375 9959	8269510718
16	Govind Kushwaha	Chironji Lal	4755 2532 6612	8269510718
17	Nidhi	Amol Singh	8318 4281 8534	9302979635
18	Anil Kushwaha	Jamuna Prasad	3799 7273 3780	6232756503
19	Neeraj Kushwaha	Ganesh Ram Kushwaha	8884 5338 6833	6232756503
20	Vandana Malviya	Aashis Malviya	2243 6074 8488	9109641478
21	Arun Kushwaha	Duli Chand Kushwaha	9137 3150 5988	6232756503
22	Subham Gurjar	Hakam Singh Gurjar	3807 2562 3654	6232756503
23	Aniket Kushwaha	Jamuna Prasad	5968 6886 9267	6232756503
24	Aman Deep Singh	Paramjeet Singh	7121 2235 4060	8269510718
25	Jaswant Gurjar	Chhote Lal Gurjar	4188 2979 4707	8109425373

List of beneficiaries from the aquaponics unit for the Self-Help Groups (SHGs) in Sankal village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name/Husband Name	Adhaar No.	Phone/ Mobile Number
1	Om Prakash Nayak	Shri Batan Lal	2330 5881 6253	7610572445
2	Banbari Nayak	Shri Batan Lal	4356 7667 9920	7610572445
3	Meena Bai Nayak	Shri Prem Narayan	3860 8760 9679	7610572445
4	Roopi Nayak	Shri Vishnu Prasad	2676 0294 9458	7610572445
5	Prem Narayan Nayak	Shri Gore Lal	4381 7623 3512	7610572445
6	Krashna Patel	Parvat Singh	6336 2585 4475	7610572445
7	Om Narayan Nayak	Shri Paras Ram	2985 9452 5098	7610572445
8	Sita Ram Nayak	Shri Munshi Lal	3956 1448 4272	7610572445
9	Narbadi Bai Nayak	Shri Sita Ram	3204 92204232	7610572445
10	Raja Ram Nayak	Shri Daulat Ram	6527 0111 1605	8818871508
11	Sumitra Bai Nayak	Shri Raja Ram Nayak	8556 0412 5929	8818871508
12	Hazari Lal Nayak	Shri Amar Singh	8891 5689 0011	8962954594
13	Leela Bai Nayak	Shri Hazari Lal Nayak	5140 4189 4897	8962954594
14	Ramkali Bai	Amar Singh	4483 6067 3827	7610572445
15	Shashi	Vinod	4312 7417 6663	7610572445
16	Nanny Bai Nayak	Shri Om Narayan	3104 4661 7042	7610572445
17	Neelam Malviya	Vikas Malviya	4528 1521 9247	8818822914
18	Krishna Malviya	Jagdish Malviya	7100 2431 3627	8109927567
19	Jamuna Prasad Nayak	Shri Raja Ram	5013 7457 3392	7610572445
20	Preeti Bai Nayak	Shri Jamuna Prasad	6032 8997 6976	7610572445
21	Raja Ram Nayak	Shri Dhanna Lal	6109 0630 7635	7610572445
22	Champa Bai Nayak	Shri Raja Ram	8494 8826 9173	7610572445
23	Pushpa Kushwaha	Rameshwar Kushwaha	3716 3688 3188	7225097545
24	Vishnu Prasad Nayak	Shri Batan Lal	5729 1725 8754	7610572445
25	Laxmi Bai Nayak	Shri Banwari	5360 0363 4488	7610572445

List of beneficiaries from the aquaponics unit for the Self-Help Groups (SHGs) in Bangrasiya village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name/ Husband Name	Adhaar No.	Phone/ Mobile Number
1	Anokhi Lal Meena	Jamuna Prasad	3869 6394 1397	8305502332
2	Arjun Meena	Anokhi Lal Meena	2253 2022 8965	7828470256
3	Aman Meena	Anokhi Lal Meena	6574 6339 8218	7828470256
4	Sanjay Meena	Kailash Meena	4220 0352 6817	8305502332
5	Surendra Meena	Kailash Meena	8510 6602 6581	8305502332
6	Satnam Singh	Paramjeet Singh	5468 8379 7103	8269510718
7	Shashi Mehra	Raju Mehra	5950 5635 3014	6232756503
8	Vijay Meena	Kailash Meena	7066 0352 6817	8305502332
9	Kamlesh Uikey	Shri Suresh Uikey	9505 8840 1063	7999788291
10	Suraj Singh Patil	Champalal	2569 6910 6702	6264815253
11	Shanti Bai	Mohan Lal	4639 9418 8096	7999788291
12	Rambati Patil	Suraj Patil	9101 8620 2448	6264815253
13	Rahul Lodhi	Jas Ram Lodhi	8419 8588 3800	8815406594
14	Ruchi Lodhi	Kedar Lodhi	8215 2749 6705	8815406594
15	Umesh Patil	Suraj Patil	7625 7055 5193	6264815253
16	Deepak Singh Uikey	Prem Chand Uikey	6138 7892 2653	7999788291
17	Sakti Pal	Babulal Pal	6952 3911 7816	8305502332
18	Lata Patel	Vishnu Prasad	2939 5665 1072	9516501609
19	Sumitra Bai	Raja Ram	9512 4401 2324	9981165825
20	Singar Bai	Mahesh Pal	3233 7493 3838	8827716036
21	Chhote Lal Pal	Radhe Kishan Pal	3541 2267 6450	9074183101
22	Anuradh	Chhedi Lal	8592 6619 7865	8305502332
23	Ajay	Sakaru	6269 5709 7650	9074183101
24	Salma Bee	Juber Khan	7250 9337 6906	9981165825
25	Love Kumar Thakur	Chandan Singh Thakur	5123 6338 2237	9630821926

List of beneficiaries from the aquaponics unit for the Self-Help Groups (SHGs) in Bagroda village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name /Husband Name	Adhaar No.	Phone/ Mobile Number
1	Raja Ram Dhurve	Salam Singh	5836 8071 1027	7697514772
2	Sheeba Bee	Safik Kha	6022 6004 9138	7389746098
3	Pawan Uikey	Rati Ram	7048 1187 4589	7224056482
4	Phoolvati Bai	Ganesh	4300 6009 9799	7441109605
5	Kanta Bhalerao	Shyam Bhalerao	4755 7693 4912	8969743168
6	Kalee Bai	Ramesh	9427 5863 8121	7225085996
7	Biniya Bai	Ganga Ram	2665 3871 2244	9630470014
8	Jyoti Bai Pal	Lakhan Pal	3315 8097 5462	9981636170
9	Gita Bai	Ram Bharose	6328 2690 8227	8602017038
10	Saroj Bai	Mahesh	6969 6303 5485	8889933806
11	Prameela Bai	Ramesh Kumar	5237 4817 5987	8889933806
12	Anita Meena	Rohit Meena	9117 3161 7884	8349174959
13	Komal Bai	Ajay Magre	4806 8359 5159	9174517058
14	Satish Malviya	Karan Singh Malviya	8669 7872 6864	7224056482
15	Savita Dhurve	Pawan Dhurve	5293 2842 4363	7224056482
16	Lalita Bai	Raja Ram Dhurve	5436 4389 0618	7697514772
17	Leela Bai	Laxman Singh	7329 7397 3911	9174517058
18	Mahesh Sen	Daulat Ram	6436 0402 5973	7224056482
19	Samina Bee	Shahid Khan	8325 0337 5883	9109528764
20	Sabiya Bee	Khalid Ali	6565 4703 1800	9109528764
21	Amreen Bee	Saleem Khan	6386 3179 0678	9340176508
22	Rani	Naseem Khan	7883 1317 6590	7879265837
23	Pinki Keer	Chhagan Singh	2274 9027 2950	9516514990
24	Ganga Bai	Vijay	3125 2922 2809	700003423
25	Raj Kumari	Mukesh Pal	5163 0858 2506	9617399256

MANIT:

We extend our appreciation to the students from the *Maulana Azad National Institute of Technology (MANIT) Bhopal* and other institutions (*Department of Zoology and Applied Aquaculture Barkatullah University and Govt, Maharani Laxmibai Girls College, Bhopal*). Approximately 75 students visited the aquaponic facility for educational exposure and practical learning, greatly enriching the academic collaboration aspect of this project.

Adoption of aquaponics technology and integration of aquaculture:

The Aquaponics System project, funded by Punjab National Bank, (Bilkhiriya Branch) is benefiting three women's Self-Help Groups Krishna Ajivika Swa Sahayta Samooh, Khushi Ajivika Swa Sahayta Samooh, and Shree Ram Swa Sahayta Samooh. This initiative supports **32** individuals in adopting aquaponics technology and integration of aquaculture as given below:

List of Beneficiaries of the Aquaponics System for **Krishna Ajivika Swa Sahayta Samooh** (SHGs) in Bilkhiriya Village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name /Husband Name	Adhaar No.	Phone/ Mobile Number
1	Sheeba Bee	Safik Kha	6022 6004 9138	7389746098
2	Phoolvati Bai	Ganesh	4300 6009 9799	7441109605
3	Kanta Bhalerao	Shyam Bhalerao	4755 7693 4912	8969743168
4	Kalee Bai	Ramesh	9427 5863 8121	7225085996
5	Biniya Bai	Ganga Ram	2665 3871 2244	9630470014
6	Jyoti Bai Pal	Lakhan Pal	3315 8097 5462	9981636170
7	Gita Bai	Ram Bharose	6328 2690 8227	8602017038
8	Saroj Bai	Mahesh	6969 6303 5485	8889933806
9	Prameela Bai	Ramesh Kumar	5237 4817 5987	8889933806
10	Anita Meena	Rohit Meena	9117 3161 7884	8349174959
11	Komal Bai	Ajay Magre	4806 8359 5159	9174517058
12	Leela Bai	Laxman Singh	7329 7397 3911	9174517058

List of Beneficiaries of the Aquaponics System for **Khushi Ajivika Swa Sahayta Samooh** (SHGs) in Bilkhiriya Village, Phanda Block, Bhopal District:

1	Samina Bee	Shahid Khan	8325 0337 5883	9109528764
2	Sabiya Bee	Khalid Ali	6565 4703 1800	9109528764
3	Amreen Bee	Saleem Khan	6386 3179 0678	9340176508
4	Rani	Naseem Khan	7883 1317 6590	7879265837
5	Pinki Keer	Chhagan Singh	2274 9027 2950	9516514990
6	Ganga Bai	Vijay	3125 2922 2809	700003423
7	Raj Kumari	Mukesh Pal	5163 0858 2506	9617399256
8	Salma Bee	Juber Khan	7250 9337 6906	9981165825
9	Sumitra Bai	Raja Ram	9512 4401 2324	9981165825
10	Singar Bai	Mahesh Pal	3233 7493 3838	8827716036

List of Beneficiaries of the Aquaponics System for **Shree Ram Swa Sahayta Samuh** (SHGs) in Bilkhiriya (Paradiya) Village, Phanda Block, Bhopal District:

S. No.	Name of Beneficiaries	Father Name/Husband Name	Adhaar No.	Phone/ Mobile Number
1	Vandana Malviya	Aashis Malviya	2243 6074 8488	9109641478
2	Nidhi Singh	Amol Singh	8318 4281 8534	9302979635
3	Krashtra Patel	Parvat Singh	6336 2585 4475	7610572445
4	Ramkali Bai	Amar Singh	4483 6067 3827	7610572445
5	Shashi	Vinod	4312 7417 6663	7610572445
6	Neelam Malviya	Vikas Malviya	4528 1521 9247	8818822914
7	Krishna Malviya	Jagdish Malviya	7100 2431 3627	8109927567
8	Pushpa Kushwaha	Rameshwar Kushwaha	3716 3688 3188	7225097545
9	Lata Patel	Vishnu Prasad	2939 5665 1072	9516501609
10	Shanti Bai	Mohan Lal	4639 9418 8096	7999788291

The NABARD DDM, Bhopal visited the aquaponics unit at Bilkhiriya village (12/03/2025).





The NABARD DDM, Bhopal visited the aquaponics unit at Bilkhiriya village (12/03/2025).