

A field Study Report on

MUSSEL FARMING AND PEARL PRODUCTION AT FISHERY RESEARCH STATION, BEGNAS



Prepared for Internal Evaluation of In-Service Training for Livestock and Fisheries Officers of Bagmati Province

Submitted To:

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ABBREBIATIONS

%	: Percentage
°C	: Degree Celsius
AD	: Anno Domini
COVID-19	: Corona Virus Disease of 2019
DAP	: Di-amonium Phosphate
et. al	: Et alia
etc	: Et cetera
FRS	: Fishery Research Station
mg/L	: Milligram per liter
PVC	: Polyvinyl Chloride
Sq. cm	: Square centimeter
SWOT	: Strengths Weaknesses Opportunities Threats

EXECUTIVE SUMMARY

The Livestock Service Training Center's recent In-Service Training program in Lagankhel, Lalitpur, provided a platform for officers from diverse backgrounds to enhance their professional skills and knowledge. The immersive field visit to Pokhara, specifically the exploration of Pearl Culture at the Fishery Research Station (FRS) in Begnas, Kaski, offered a unique perspective on aquaculture and the intricate processes involved in pearl farming. The historical evolution of FRS, Begnas, highlights its commitment to sustainable fisheries development, positioning it as a crucial force for positive change in western Nepal.

The study focused on mussel farming and pearl production, with *Lamellidens marginalis* showing significant potential. The detailed methodology, from collection to harvest, outlined the intricate processes involved. The SWOT analysis identified strengths such as suitability for diverse regions and integrated farming opportunities, along with weaknesses, opportunities, and threats. Leveraging strengths and addressing challenges is crucial for the sustainable development of mussel farming and pearl production in Nepal.

Recommendations include increased funding for research and development, awareness programs for farmers, a comprehensive policy framework, community engagement, technology transfer, and diversification of mussel-derived products. Implementing these recommendations will contribute to the holistic growth of this emerging sector, ensuring economic, environmental, and social benefits in Nepal.

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1. INTRODUCTION

1.1 General Background

In the pursuit of enhancing professional skills and knowledge, officers from Livestock and Fisheries sector under the Ministry of Agriculture and Livestock Development and Local level of Bagmati Province recently participated in a specialized In-Service Training program organized by the Livestock Service Training Center located at Lagankhel, Lalitpur. The program aimed to equip participants with advanced insights and practical experiences related to their respective fields. As part of the training initiative, a unique opportunity unfolded for 18 participants who embarked on a field visit to the beautiful city of Pokhara. To maximize the learning experience, the cohort was divided into six groups, each assigned a distinctive topic for comprehensive exploration.

Among these groups, our group had the privilege of experiencing the fascinating sector of Pearl Culture at the Fishery Research Station situated at Begnas, Kaski. This topic not only offered a novel perspective on aquaculture but also provided an overall understanding of the processes involved in cultivating pearls within a research-driven environment. Throughout the field visit, participants engaged in hands-on activities, interactive sessions, and discussions with experts in the field. The experience not only broadened our knowledge but also fostered a collaborative learning environment as we navigated the challenges and opportunities of mussel culture and pearl production.

Overall, the Officer Level In-Service Training, organized by the Livestock Service Training Center, not only served as a platform for professional development but also facilitated networking and knowledge-sharing among participants. The diverse array of topics and field visits ensured a well-rounded learning experience, empowering officers to apply their newfound knowledge and skills in their respective roles.

1.2 Contextual Perspective

Established in 1962 as the "Lake Development Centre" and subsequently rebranded as the Fisheries Research Station in 1990s, this institution has stood as Nepal's commitment to the enhancement of fisheries and aquaculture, particularly with a focus on uplifting the livelihoods of wetland-dependent rural communities (Frspokhara.gov.np, 2024). The goal of the Fisheries Research Station is to significantly enhance the contribution of fisheries and aquaculture to the livelihoods of communities, especially those reliant on wetlands. Through a multi-faceted approach, the institution has outlined specific objectives that encompass technological innovation, resource conservation, community engagement, and sustainable aquaculture practices. One of the primary objectives of the center is the development of appropriate aquaculture technologies to improve production and productivity. This involves continuous

research and innovation in areas such as fish nutrition, physiology, genetics, and pathology, aimed at developing intensive warm freshwater fish farming systems for both native and exotic species. Selective breeding techniques are employed to enhance the stock performance of aquaculture species, ensuring improved yields and economic benefits for the farming community. This aligns with the broader goal of ensuring environmental, social, and economic viability of aquaculture technologies and fish farming systems.

The FRS, Begnas also actively engages in the development of small-scale and low-input-based fish farming, specifically tailored for ultra-poor communities. This inclusive approach aims to empower marginalized groups, providing them with the means to improve their economic standing through sustainable aquaculture practices. To facilitate the dissemination of knowledge and resources, the institution emphasizes the appropriate delivery of technical and resource services to farmers and fishers in western Nepal. Through participatory fish stock enhancement and demonstrations of fisheries co-management in lakes and streams, the center promotes community engagement and empowerment, fostering a sense of ownership and responsibility among local stakeholders (Annual Report 2078/79, FRS).

The idea of initiating mussel farming and pearl production at FRS Begnas originated after a visit to India and a thorough review of relevant literature. Subsequently, in 2017, a proposal for this project was submitted to the government, leading to the commencement of the project. Mussel farming officially began in 2018 AD, at FRS Begnas as well as Rupa Lake involving the collection of mussels from local canals and ponds, marking the initiation of pearl production. Due to the impact of COVID-19, the project experienced disruptions that affected both pearl production and management. In 2023, the research yielded positive results, demonstrating a success rate of approximately 50% in obtaining pearls from the cultivated mussels. Pearl production proved to be more effective at Rupa Lake than in FRS ponds, attributed to the lake's richer and more natural water conditions. This observation highlights the significant potential for successful pearl production at Rupa Lake. Breaking away from the traditional concept that pearls can only be produced in seas and oceans, this project has demonstrated that pearls can be successfully cultivated in freshwater, including within the context of Nepal.

1.3 Objectives

- To explore mussel farming and pearl production techniques at FRS, Begnas

1.4 Rationale of Study

Freshwater pearl culture is one of the emerging areas in aquaculture sector. The freshwater mussels which produce pearl are available abundantly in easily accessible natural water bodies like ponds, ditches, canals and river, etc. in Nepal. Nepal possesses rich biodiversity of

freshwater mussel (Subba and Pandey, 2005), out of which three species such as *Lamellidens marginalis*, *L. corrianus* and *Parreysia corrugata* are found to possess high potential for pearl formation. A wider area of inland fish farming is available in various regions of the country. A huge profit can be made in a successful culture operation, as pearls are still in high demand world over. It is very expensive and Nepalese farmer's income could be increased by pearl culture. Pearls are used for decorative and jewelry purposes. In addition, they have also been used as medicine to cure insanity, powdered for pharmaceutical preparations like potions, balms, and salves to treat a wide variety of ailments and prescribed for treatments include memory loss, insomnia, asthma, jaundice, liver ailments, heart problems, infertility and also in insect or snake bites (Kaushik et. al, 2015).

1.5 Limitations of Study

Due to a public holiday, we were unable to meet and interact with all the staff members, hindering our ability to conduct interviews and gain insights into the managerial and other aspects of mussel farming from their perspective.

2. REVIEW OF LITERATURE

Lamellidens marginalis, commonly known as the Indian freshwater pearl mussel, is widely distributed across South Asian freshwater ecosystems. *Lamellidens* belongs to the class Pelecypoda phylum Mollusca. Fresh water mussels live in ponds, lakes, slow moving streams distributed throughout Indian subcontinent (Wikipedia, 2021). The mussels remain partially embedded in mud or sand at the bottom of a water body. On slight disturbance, the foot and siphons are withdrawn inside the shell and the gap between the valves of the shell is tightly closed. The mussel is enclosed in a hard, calcareous, horny-blackish, bivalve shell (Shriya, 2017). The adult mussel is about 10 cm in length. The body is light cream in colour, soft, elongated oval with a somewhat broad and a narrow posterior end. A mantle or pallium having two equal halves, the mantle lobes, lines the inner surface of the shell and encloses a space, the mantle cavity. The shell consists of two equal halves or valves made of conchiolin and calcic substances.



Figure 1. *Lamellidens marginalis*

Its significance in pearl culture stems from its ability to produce pearls of varying colors, shapes, and sizes. *Lamellidens marginalis* possesses unique characteristics that make it a suitable candidate for pearl farming. Researchers have conducted extensive studies on the anatomy, physiology, and life cycle of these mollusks to better understand their reproductive patterns and the factors influencing pearl formation (Ahirwal et. al, 2022).

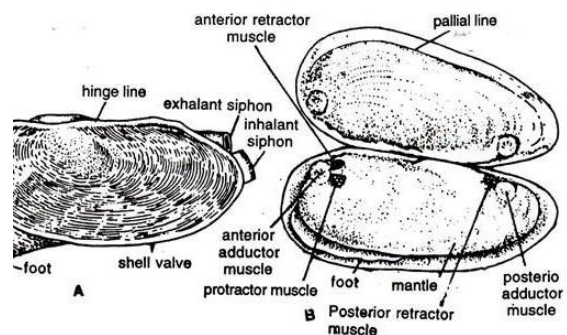


Figure 2. Anatomy of *L. marginalis*

Studies on *Lamellidens marginalis* have highlighted its filter-feeding nature, relying on plankton and organic matter for sustenance. This feeding behavior contributes to the bivalve's role in maintaining water quality, making it an ecologically significant species beyond its economic value in pearl culture (Vikaspedia, 2024).

Till now there are no proved technologies available in Nepal for pearl production, but Nepal imports pearls from various country. Pearl is natural gem produced by mussels. For millennia, pearls have fascinated humanity the world over. In ancient times, the demand was met by natural production (Subba and Ghosh, 2001; 2008). However, to meet the rising demand of pearls in the modern world, entrepreneurs and researchers reported production of pearls by culturing pearls producing oysters and mussels. Recent trends showed India, Bangladesh, China as well

as Japan (Misra et al. 2009; Janakiran 2003) and several other countries had developed freshwater pearl cultivation technologies abroad.

The grafting process is the crux to success in any pearl culture operation. Natural pearl formation is instigated when a foreign particle such as a piece of sand, shell piece or parasite make its way into region of mollusk and cannot be expelled (Yadav and Subba, 2008). Cultured pearls are formed essentially by the same process, except that the irritant, otherwise called a nucleus, of desired shape and size is surgically implanted into the body of bivalve mollusk where it is difficult to be expelled (Misra et al., 2009). Mental cavity implantation and rearing of implanted mussels in nylon bag is the most suitable combination for producing freshwater pearls in *L. marginalis* (Pandey and Singh, 2015). The implanted mussels cultured in the ponds for 12-18 months (Miah et. al, 2000).

3. METHODOLOGY

The methodology employed in this study comprises several key components. The period of the study was from 26th of Poush to 29th of poush. It involves the utilization of semi-structured methods, incorporating open-ended questionnaires and interviews with Dr. Mohammad Akbal Husen, the Office Chief. Additionally, the study incorporates direct observation of the field and farm at Fishery Research Station (FRS) Begnas and staffs of Rupa Lake Restoration and Fisheries Co-operatives, Rupa rural Municipality. A comprehensive review of publications from FRS Begnas, specifically those related to pearl farming, is also an integral part of the research methodology. This multi-faceted approach is designed to provide a nuanced and comprehensive understanding of the dynamics of pearl farming at FRS, Begnas.

4. RESULTS/FINDINGS

As part of our study, we visited Fishery Research Station, Begnas and Rupa Lake, where we engaged with the staff and Chief of FRS, Begnas. We observed the farms, laboratory, and mussel cultivation at Begnas and Rupa Lake. Our study yielded various results and findings related to mussel farming and pearl production, which are detailed below.

4.1 Collection, Identification and Rearing of Mussels in Captivity

Healthy mussels are manually collected from freshwater bodies such as ponds and rivers. Once collected, they are carefully placed in buckets or containers filled with water. The mussels sourced from the drainage canal were identified as *Lamellidens marginalis*, a species chosen for pearl farming. Subsequently, these identified mussels are cultivated in the canals and ponds of Fishery Research Station (FRS), Begnas.

4.2 Maintenance of Mussels Stock

Mussels are cultivated in the drainage canals, ponds, and tanks at Fishery Research Station (FRS), Begnas. Their diet primarily consists of natural phytoplankton that develops in the ponds. To enhance phytoplankton density, urea and DAP fertilizer are applied on a weekly basis. In the tanks, artificial feed in the form of powdered feed is provided to sustain the mussels.

4.3 Feeding and Water Quality for Mussel Farming

The ponds selected for pearl culture are regularly fertilized with compost, urea, and DAP to sustain optimal phytoplankton levels.

Table 1. Water Quality Parameters Recorded in Pearl Culture Pond

S.N.	Parameters	Range
1.	Temperature (°C)	13.7-30
2.	Dissolved Oxygen (mg/l)	5.1-9.5
3.	pH	7.1-8.4
4.	Total alkalinity (mg/l)	37.0 – 54.0
5.	Total Hardness (mg/l)	61.0-75.0
6.	Secchi disc reading (cm)	32-38

Annual Report 2078/79 (FRS, Begnas)

4.4 Establishment of Mussels Grafting Facility

The procurement of mussel grafting materials, including spatulas, knives, mortar and pestle, and an instrument box are completed. Both image beads and circular beads are prepared for the implantation process in the mussels.

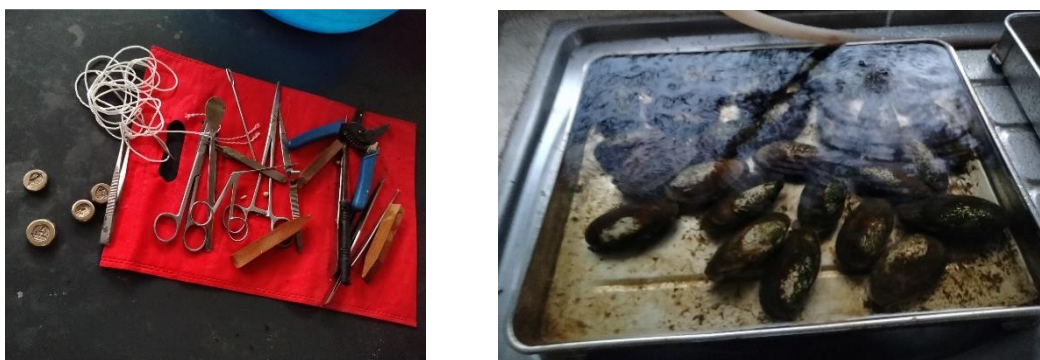


Figure 3. Surgical equipments for bead implantation and pre conditioning of *L. marginalis*

4.5 Methods of Image and Circular Bead Preparation

Materials Required: Mussel shells, mortar and pestle, bleaching powder or lime, sieve, araldite (epoxy adhesive), molds, forceps, needles.

Procedure:

- Soak the shells of deceased mussels in a lime and water solution for 10-14 days, stirring periodically. Alternatively, bleaching powder can be used to expedite the process.
- Once the shells attain a whitish color after the desired soaking period, remove them, wash with water, and allow them to sun dry.
- Grind the sun-dried shells into a powder using a mortar and pestle, and then sieve the powder.
- Prepare a dough using the araldite adhesive, taking equal parts, mixing them thoroughly, and adding the powdered shells. Ensure the mixture is well blended.
- Take a small quantity of the dough and place it into molds to form the desired images.
- Create circular beads using your fingers and palms.
- This procedure outlines the steps for preparing materials from mussel shells, emphasizing proper cleaning, drying, and processing techniques to form both images and circular beads.



Figure 4. *L. marginalis* shells, crushed powder, beads prepared

4.6 Pre-Operative Conditioning

The collected mussels are kept for pre-operative conditioning for 2 to 3 days by keeping them in crowded condition in captivity with tap water. This practice facilitates the weakening of adductor muscles, making it easier to handle the mussels during surgery.

4.7 Implantation for Pearl Culture

Mantle cavity implantation: In this procedure round (4-6 mm diameter) or designed (images of Ganesh, Buddha, etc.) beads are inserted into the mantle cavity region of mussel after opening the two valves (without causing injury to mussels at both ends) of mussel and carefully separating the mantles of anterior sides from the shell with the help of surgical set. Implantation could be done in mantle cavities of both the valves. In case of implantation of designed beads care is taken such a way that the design portion faces the mantle. After placing the beads in desired place, the gaps created during implantation are closed just by pushing the mantle onto the shell.



Figure 5. Bead implantation

4.8 Post-Operative Care

Implanted mussels are kept in post-operative care unit in nylon bags for 3-5 days with antibiotic treatment and supply of natural food. The units are examined daily with removal of dead mussels and the ones that reject the nucleus.

4.9 Transfer and Rearing of Implanted Mussels

After post-operative care the implanted mussels are stocked in the ponds and cemented tank for culture. The mussels are kept in nylon bags (1 cm mesh-12 sq. cm) at the rate of 1-2 mussels per bag and are hung from bamboo or PVC pipes and placed in ponds under water. The mussels are cultured at stocking density of 20,000 -30,000/ha. Periodical checking of mussels with removal of dead ones and cleaning of bags is required throughout the culture period of 12-18 months. The culture units require periodic cleaning of accumulated silt and other fouling fauna, finding entry into the units.

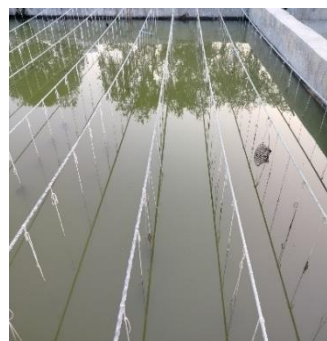


Figure 6. *L. marginalis* kept in Nylon bags and hung in pond for rearing

The water quality especially phytoplankton populations were managed through manuring pond and tank with DAP and Urea biweekly. The physio- chemical parameters and water level of the ponds are to be monitored throughout the culture period of the mussels. The optimum temperature regime lies between 25°C to 30° c. The fresh-water pearl culture pond environment is generally same as employed for the aquaculture of the carps.

The ponds are fertilized with organic and inorganic fertilizer periodically to sustain the plankton productivity. Once the fertilizer degrades (7 to 10 days), the green water develops. The algal enriched water is lead into the pearl culture ponds. The mussels by virtue of being mucoid filter feeders can accept a variety of particular organic materials feed. The pearl mussels in captive culture conditions can be maintained on a diet of powdered rice bran and mustard oil cake (1:1 ratio) at 1% of the weight of the mussels provided on alternate day basis.

4.10 Food and Feeding

Algae, being the predominant component of the first trophic level in aquatic food chain have got much importance in aquaculture systems. Some species of algae belonging to Chlorophyta (green algae), Bacillariophyta (Diatoms) and Cyanophyta (blue green algae) are normally used as feed by the freshwater mussels. The commonly preferred algal species by the freshwater mussel *Lamellidens marginalis* are diatoms green algae (*Chlorella chlorococcum*, *Scenedesmus* etc.) and blue green algae (Spirulina). Culture vessels and tanks of desired capacities are to be selected prior to algal culture.

4.11 Pearl Formation and Harvest

The pond culture of operated mussels varies from twelve month or more depending upon the size and number of nuclei implanted, the health of the mussels and the condition of the pond environment. At the end of the culture period the mussels are harvested. The mussels are either crushed following by sieving to extract pearl or the mussel is individually sacrificed.

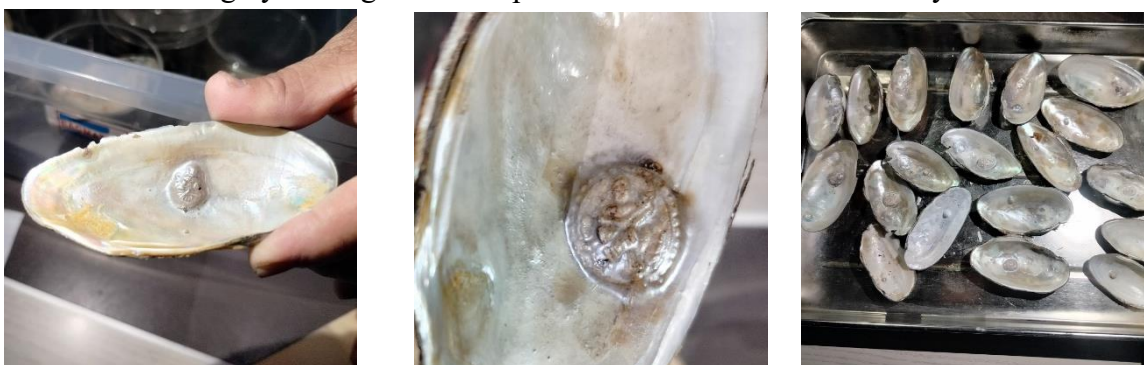


Figure 7. Pearl formation

The culture period is generally about 12 to 18 months, depending on the size and number of bead implanted. The mussels are opened one by one and the half round or design, shell attached pearls are cut out of the shell valves. One to two attached pearls are obtained, depending on the number of bead inserted. The success rate is about 50-60 % of the mussels implanted.

5. SWOT Analysis

5.1 Strengths

- **Suitable for farming:** Mussels are readily available in almost all water resources, ranging from the mid-hills to the Terai region. The water temperature and climate in these areas are conducive to successful mussel farming.
- **Integrated farming:** Mussel farming can be integrated with fish farming and other forms of aquaculture.
- **Multiple harvest and multiple income:** Multiple harvests (Mussel, fish and pearl) can be obtained from a single pond through integration, providing farmers with multiple sources of income.
- **Multi-purpose of mussels:** Every product from mussels can be utilized, including meat for consumption and the outer shell for bead preparation. It also has medicinal and pharmaceutical value.
- **Low-cost farming and high return:** The farming cost for mussel farming and pearl production is relatively low, yet pearls have a high market value, resulting in substantial high returns for farmers.
- **High Nutrition value:** Mussels have a high nutritional value, comprising 48% protein and significant amounts of calories, fat, calcium, potassium, iron, and vitamins.

5.2 Weaknesses

- **Limited Research:** There has been very limited research in Nepal, with only one study conducted at FRS, Begnas, which is also ongoing.
- **Lack of knowledge and awareness:** There is a lack of knowledge about the nutritional value of mussels and about pearl production among consumers and farmers.
- **Lack of skilled and trained manpower:** Knowledge and expertise in pearl farming is limited which requires training and capacity building to technicians and farmers.
- **Not suitable for higher altitude:** Mussel farming requires a relatively warmer temperature ranging from 13-30 degrees Celsius, which may not be suitable for the high hills and mountains of Nepal.

5.3 Opportunities

- **Market demand:** The increasing demand in the market for pearls produced locally can be utilized to achieve economic benefits.
- **High price value:** Pearls have a high market value, ranging from Rs. 2000-3000, depending on their size and luster.
- **Export Potential:** High-quality, locally produced pearls could have international market opportunity, as pearl have demand in other south Asian countries and all over the world.
- **Sustainable aquaculture practice:** Focusing on sustainable and eco-friendly pearl production aligns with global trends, providing an opportunity for market differentiation.

- **Research Collaboration:** Collaborating with research institutions or industry partners can bring in new insights and advancements in pearl farming techniques.
- **Food security:** Mussel farming and consumption can contribute to national food security due to their high nutritional value and the cost-effectiveness of the farming process.

5.3 Threats

- **Climate change:** Changes in water quality, climate, or other environmental factors can pose a threat to mussel health and, consequently, pearl production.
- **Global competition:** Competition from cheaper or more established sources of pearls in the market may pose a challenge.
- **Budget limitations:** Limited budget allocations from the federal, provincial, and local government can constrain the research and production facilities for mussel farming and pearl production.
- **Lack of government policy:** There is a lack of appropriate policies and planning related to pearl production, which consequently results in a lack of research and extension activities.
- **Social perception:** Mussels are generally not consumed by all social and ethnic groups, which may pose a threat to their development.

6. CONCLUSION AND SUGGESTIONS

In conclusion, the Livestock Service Training Center's In-Service Training program, particularly our exploration of pearl culture at FRS, Begnas, stands as a pivotal experience for professional growth. Our study focused on mussel farming and pearl production, showcasing the potential of *Lamellidens marginalis*. The detailed methodology, from collection to harvest, outlined the intricate processes involved. The SWOT analysis revealed opportunities for market demand and sustainable practices, but challenges such as limited research and climate sensitivity must be addressed. Leveraging strengths and capitalizing on opportunities, coupled with addressing weaknesses and mitigating threats, is essential for the sustainable development of mussel farming and pearl production in Nepal.

There is a crucial need to augment funding for research and development to overcome existing limitations and stimulate innovation. Concurrently, awareness programs targeting farmers and local communities should be initiated, accompanied by training sessions to build technical expertise. A comprehensive policy framework is essential to provide regulatory support for promoting mussel farming and pearl production. Strengthening community engagement and ensuring inclusivity, particularly among marginalized groups, is vital. Successful technologies from institutions like FRS, Begnas, must be transferred to extension organizations and farmers. Diversification of mussel-derived products and the development of a long-term sustainability plan will further contribute to the holistic growth of this emerging sector, ensuring economic, environmental, and social benefits.

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APPENDICES

