



Comprehensive Report

TRISA Project



Executive Summary

Overview

The TRISA project, in partnership with Veterinum (Montenegro), successfully revolutionized the field of animal feed and waste management by introducing Tenebrio Molitor (TeM) larvae technology. The project was achieved through a three-phased approach: conducting feasibility studies, transferring technology and training local workers, and scaling the initiative for broader impact.

Partners and Stakeholders

The main partner, Veterinum, offered unparalleled expertise in specialized animal feed and was responsible for local adaptation, production, and distribution in Montenegro. Additional stakeholders included local farmers, waste management entities, and government bodies, who shared challenges in food security and environmental sustainability.

Target Beneficiaries

1. **Farmers and Livestock Owners:** Benefited from chance to achieve reduced operational costs through alternative feed.
2. **Waste Management Entities:** Gained an eco-friendly solution for organic waste bioconversion.
3. **Local Governments:** Presented possibility to ease pressure on public resources and increased local food security.
4. **Consumers:** More affordable and sustainable animal-derived food products.

Core Activities

1. **Feasibility Studies:** Conducted market research, technological assessments, and financial planning in collaboration with Veterinum.
2. **Technology Transfer and Training:** Established pilot breeding centers for TeM larvae and trained local workers.
3. **Implementation and Scaling:** Expanded the initiative based on successful pilot tests.

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Outcomes

- **Increased Food Security and Sustainability:** Achieved through the adoption of TeM larvae as an alternative, sustainable animal feed.
- **Effective Organic Waste Management:** Implemented by using organic waste for TeM larvae breeding.
- **Upskilling of the Local Workforce:** Provided training that equipped local workers with the necessary skills to manage and expand the new technology.
- **Economic Uplift for Farmers:** Resulted from lower feed costs and the potential for waste-to-feed conversion revenue streams.

Conclusion

The TRISA project provided a holistic, adaptable, and sustainable solution for some of Montenegro's most pressing issues: food security and waste management. It aligned closely with the goals of the ODA Challenge Call, offering innovative, scalable solutions that promise long-term benefits for a wide range of stakeholders. Through strategic partnerships, good planning, and a focus on both immediate needs and long-term sustainability, TRISA set a new standard in the sectors it aimed to revolutionize .



Introduction

Background and Objectives

The *Tenebrio Molitor* (TeM) Breeding Initiative, realized at the Veterinum Pilot Breeding Centre in Ulcinj, Montenegro, was conceived as a response to the pressing challenges of food security, sustainable agriculture, and waste management. This project was a collaboration between Belinda Animals and Veterinum, supported by the United Nations Development Programme (UNDP) under the ODA Challenge Call. The initiative aimed to harness the potential of TeM larvae as a sustainable protein source and a solution for bioconverting organic waste, thereby addressing critical issues faced by local communities and the broader agricultural sector.

The primary objectives of the project were:

- To establish a pilot breeding centre for TeM larvae.
- To transfer innovative breeding technology and practices to local stakeholders.
- To train and upskill local workers, farmers, and agricultural professionals.
- To create a sustainable model that could be scaled and replicated in other regions.

Project Scope

The project was structured into three main phases:

1. **Preparation and Planning:** This phase involved conducting feasibility studies, engaging with stakeholders, and detailed project planning. Feasibility studies included market research and technological assessments, which were critical for tailoring the project to local conditions and ensuring its sustainability.
2. **Technology Transfer and Training:** The second phase focused on the physical setup of the breeding centre, procurement and installation of necessary equipment, and extensive training sessions. The training covered the entire spectrum of TeM breeding, from setting up the infrastructure to managing the lifecycle of the larvae and processing finished products.

3. **Implementation and Scaling:** The final phase involved the operationalization of the breeding centre, continuous monitoring and evaluation, and the development of strategies for scaling the initiative. This phase also included promotional activities to raise awareness about the benefits of TeM larvae and engage the broader community.

Stakeholders and Partnerships

The success of the TeM Breeding Initiative hinged on the collaboration and support of various stakeholders:

- **Veterinum (Montenegro):** As the main project partner, Veterinum provided essential expertise in specialized animal feed. Their role included local adaptation, production, and distribution of TeM larvae, as well as the management of the breeding centre.
- **Belinda Animals:** Provided technical expertise, training, and continuous support throughout the project. Their involvement ensured the transfer of technology and best practices to the local context.
- **Local Farmers and Agricultural Workers:** Benefited directly from the training and the innovative breeding techniques introduced. Their participation was crucial for the practical application and success of the project.
- **Local Government Representatives:** Supported the project by facilitating regulatory compliance and providing a link between the project team and the broader community. Their involvement helped ensure that the project's objectives aligned with local agricultural policies and development goals.
- **UNDP:** As the funding and strategic partner under the ODA Challenge Call, UNDP provided critical financial support and oversight, ensuring that the project met its objectives and contributed to broader sustainable development goals.

Specific Results and Experiences

The project has already yielded significant results and insights:

- **Establishment of the Pilot Breeding Centre:** The centre was successfully set up with advanced climate control systems, optimal breeding conditions, and

robust operational protocols. The facility spans over 30m² and is equipped with breeding and monitoring equipment.

- **Training and Capacity Building:** Comprehensive training sessions were held, covering all aspects of TeM breeding. The training not only enhanced the skills of Veterinum staff but also engaged local farmers and government representatives, ensuring a broad base of knowledge and support for the initiative.
- **Production and Scaling:** The project saw the successful establishment of 10 new batches of TeM larvae, in addition to the existing 5 batches, resulting in a total of 15 active batches. This significant increase in production capacity positions the centre as a potential vertical farm and a key provider of initial TeM colonies for other agricultural companies.
- **Research and Innovation:** Veterinum initiated research into the applications of TeM products, such as oil and protein flour, for feeding bees. This research is supported by rigorous analyses and efforts to obtain necessary permits and market declarations.

The Tenebrio Molitor Breeding Initiative at the Veterinum Pilot Breeding Centre stands as a testament to the power of collaborative efforts and innovative solutions in addressing some of the most pressing challenges in agriculture today.



Preparation and Planning

Initial Concept and Feasibility Studies

The concept of the Tenebrio Molitor (TeM) Breeding Initiative was born out of a need to address the connected challenges of food security, sustainable agriculture, and effective waste management. The initial concept aimed to leverage the potential of TeM larvae as a sustainable source of protein and a means for bioconverting organic waste.

The feasibility studies were a critical first step in ensuring the project's viability. These studies encompassed several key areas:

1. **Market Research:** Comprehensive market research was conducted to understand the demand for TeM larvae and their potential applications in the local agricultural sector. This included analyzing market trends, pricing structures, and the competitive landscape.
2. **Technological Assessment:** An evaluation of the available technologies for TeM breeding was performed. This assessment identified the most suitable technologies for breeding, climate control, and waste management that could be adapted to local conditions.

The feasibility studies provided a solid foundation for the project's planning and highlighted the economic and environmental benefits of adopting TeM larvae breeding in Montenegro.

Stakeholder Engagement and Consultations

Engaging with stakeholders was a crucial aspect of the preparation phase. Early and continuous consultations ensured that the project aligned with the needs and expectations of all involved parties. Key stakeholder engagements included:

1. **Veterinum (Montenegro):** As the main project partner, Veterinum's involvement was integral from the beginning. Their expertise in specialized animal feed and local knowledge were invaluable in shaping the project's direction.
2. **Local Farmers and Agricultural Workers:** Consultations with local farmers and agricultural workers helped identify their needs and concerns. These discussions ensured that the training programs and project activities were tailored to be practical and beneficial for them.

3. **Local Government Representatives:** Engaging with local government officials helped in understanding regulatory requirements and aligning the project with local agricultural policies. Their support was crucial for obtaining necessary permits and ensuring smooth project implementation.
4. **UNDP:** Regular consultations with UNDP ensured that the project met the criteria of the ODA Challenge Call and aligned with broader sustainable development goals. Their strategic oversight and financial support were instrumental in the project's success.

These engagements fostered a collaborative environment and ensured that the project had broad-based support from all relevant stakeholders.



Project Realization

Infrastructure Setup

The realization of the Tenebrio Molitor (TeM) Breeding Initiative commenced with the establishment of the necessary infrastructure at the Veterinum Headquarters in Ulcinj. This phase was critical to ensure that the breeding centre was fully equipped to meet the project's objectives.

Breeding Facility Design:

- **Space Allocation:** A dedicated 30m² room was allocated for the breeding operations. The space was chosen for its accessibility, ease of maintenance, and suitability for housing sensitive breeding equipment.
- **Structural Modifications:** The room was modified to include insulated walls and tiled floors. These modifications ensured optimal thermal insulation, easy cleaning, and high hygiene standards.
- **Environmental Controls:** The facility was equipped with advanced climate control systems capable of maintaining precise temperature and humidity levels essential for the optimal growth of TeM larvae.

Facility Preparation:

- **Cleaning and Disinfection:** Before the installation of equipment, the breeding room underwent thorough cleaning and disinfection to eliminate any potential contaminants.
- **Setup of Workspaces:** Dedicated workspaces were created for staff to perform daily operations efficiently. These spaces were designed to facilitate the smooth execution of breeding processes and ensure the safety and comfort of the workers.

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Equipment Procurement and Installation

Procuring and installing the right equipment was crucial for the success of the breeding centre. This phase involved careful selection, acquisition, and setup of breeding and monitoring equipment.

Equipment Selection:

- **Breeding Containers:** Specialized containers designed for different life stages of TeM larvae were procured. These containers ensured optimal conditions for breeding, hatching, and larval development.
- **Climate Control Systems:** High-efficiency air conditioning unit, along with automatic humidifier, were installed. These systems included integrated sensors for continuous monitoring and adjustment of temperature and humidity.
- **Feeding and Waste Management Systems:** Equipment for feeding the larvae and managing organic waste was selected based on efficiency and ease of use.

Installation Process:

- **System Integration:** All equipment was carefully installed and integrated to work seamlessly together. This involved setting up climate control systems, connecting monitoring sensors, and placing breeding containers in optimal configurations.
- **Testing and Calibration:** Post-installation, all systems were tested and calibrated to ensure they met the required operational standards. This step was critical to ensure the equipment functioned correctly and efficiently.

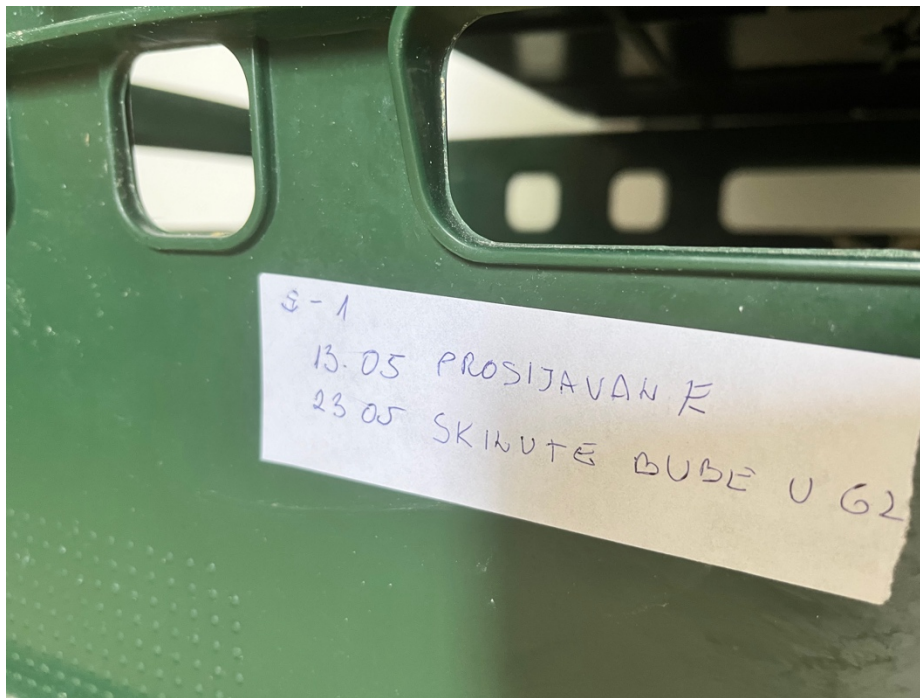


Environmental and Regulatory Compliance

Ensuring compliance with environmental and regulatory standards was a key component of the project realization phase. This ensured that the breeding centre operated within legal frameworks and adhered to best practices for sustainability.

Environmental Compliance:

- **Waste Management:** Systems were put in place to manage organic waste generated by the breeding processes. This included safe disposal methods and protocols for converting waste into useful by-products.
- **Energy Efficiency:** The facility was designed to be energy-efficient, minimizing its environmental footprint. Climate control systems were selected for their low energy consumption and high efficiency.
- **Health and Safety Standards:** The breeding centre adhered to stringent health and safety standards to protect both the workers and the larvae. Regular inspections were conducted to ensure ongoing compliance with these standards.



Training and Capacity Building

Training Needs Assessment

The training needs assessment was a critical initial step in the Tenebrio Molitor (TeM) Breeding Initiative. This phase aimed to identify the specific skills and knowledge gaps among the stakeholders, including the Veterinum staff, local farmers, and agricultural workers.

Key Findings:

- **Knowledge Gaps:** It was found that there was a general lack of understanding of TeM breeding techniques and the benefits of TeM larvae as a sustainable protein source.
- **Technical Skills:** The assessment revealed the need for training in specific technical skills, such as climate control, larvae management, and the processing of TeM products.
- **Operational Practices:** There was a need to standardize operational practices to ensure the efficient and hygienic handling of larvae.
- **Sustainability Practices:** Stakeholders required training on sustainable agricultural practices and the integration of TeM breeding into existing farming systems.

These findings informed the development of tailored training modules designed to address the identified gaps and equip stakeholders with the necessary skills and knowledge.

Development of Training Modules

Based on the training needs assessment, comprehensive training modules were developed to cover all aspects of TeM breeding. The modules were designed to be practical, interactive, and accessible to participants with varying levels of prior knowledge.

Core Modules Included:

1. Introduction to Tenebrio Molitor Breeding:

- Overview of the biological and ecological aspects of TeM larvae.
- Benefits and applications of TeM larvae in sustainable agriculture.

2. Breeding Techniques:

- Detailed instructions on setting up a breeding facility.
- Lifecycle management of TeM larvae, including breeding, hatching, and development stages.

3. Environmental Control:

- Best practices for maintaining optimal temperature and humidity levels.
- Use of climate control systems and monitoring equipment.

4. Larvae Management and Handling:

- Guidelines for feeding, handling, and caring for TeM larvae.
- Strategies for managing waste and ensuring hygiene.

5. Product Processing:

- Techniques for processing TeM larvae into various products, such as oil and protein flour.
- Emphasis on the sustainability and economic viability of TeM products.

6. Sustainability and Integration:

- Methods for integrating TeM breeding into existing agricultural practices.
- Approaches to promote sustainable farming and waste management.

The modules were developed using insights from the TM TRISA Book and tailored to the specific context of the project.

Training Sessions and Workshops

The training sessions and workshops were meticulously planned and executed to ensure maximum engagement and knowledge transfer.

Training Details:

- **Date and Venue:** The training sessions were held on April 23, 2024, at Hotel Barjaktar and the Veterinum Headquarters in Ulcinj. The sessions ran from 09:00 AM to 02:30 PM.
- **Participants:** A total of 22 participants attended the training, including staff and local workers, representatives from small farms, and local government officials dealing with agriculture.
- **Training Structure:** The training comprised theoretical presentations, interactive discussions, and practical demonstrations.

Session Highlights:

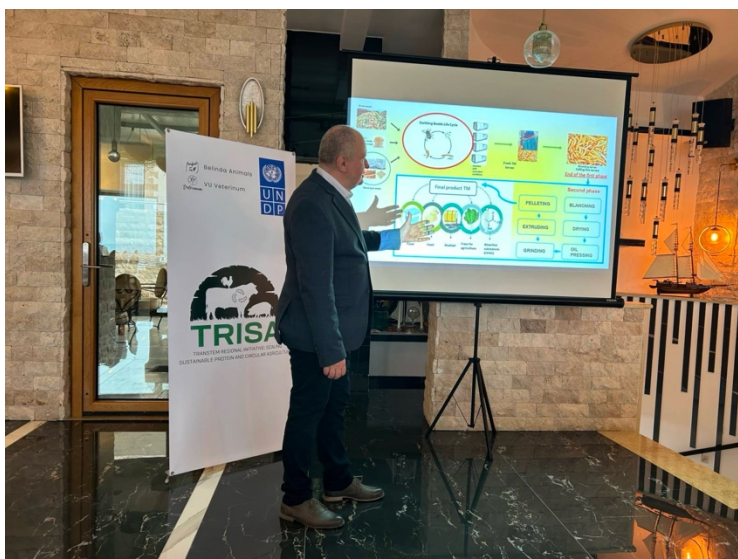
1. Theoretical Training:

- Comprehensive overview of the TRISA project and its objectives.
- Detailed coverage of all training modules, including breeding techniques, environmental control, and product processing.

2. Practical Demonstrations:

- On-site visit to the Veterinum Pilot Breeding Centre.
- Live demonstrations of the handling processes and various stages of larvae development.
- Inspection of breeding equipment and facilities.

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Participant Feedback:

- **Engagement and Interaction:** Participants showed a high level of engagement and interaction, indicating strong interest and the practical relevance of the training content.
- **Knowledge Transfer:** Feedback suggested that the training successfully conveyed the necessary knowledge and skills, with clear explanations and comprehensive coverage of all topics.
- **Satisfaction:** Participants expressed high satisfaction with the quality and depth of the training. They appreciated the clarity of the presentations and the expertise of the trainers.
- **Practical Application:** Many attendees, particularly those from small farms and local government, valued the practical demonstrations and expressed confidence in applying the learned techniques to their operations.

Recommendations for Future Training:

- **Follow-Up Sessions:** Organize follow-up training sessions to cover advanced topics and provide updates on new technologies and methodologies in TeM breeding.
- **Increased Hands-On Training:** Incorporate more practical exercises and interactive sessions in future trainings to enhance hands-on learning experiences.

The training and capacity building efforts were a resounding success, significantly enhancing the participants' knowledge and skills related to sustainable agriculture practices involving TeM larvae. The enthusiasm and positive feedback from all attendees underscore the importance and potential impact of this training on local agricultural practices.

Opening of the TeM Centre

Inauguration Ceremony

The inauguration of the Tenebrio Molitor (TeM) Pilot Breeding Centre at the Veterinum Headquarters in Ulcinj was a significant milestone in the project. The ceremony, held on [Insert Date], marked the official commencement of the breeding operations and showcased the collaborative efforts of Belinda Animals, Veterinum, and supporting organizations.

The event was attended by key stakeholders, including project partners, local farmers, government officials, and representatives from the United Nations Development Programme (UNDP). The inauguration highlighted the importance of the TeM breeding initiative in promoting sustainable agriculture and food security in Montenegro.

Keynote Speeches

The ceremony featured several keynote speeches from prominent figures involved in the project:

1. Representative from Belinda Animals – MSc Boris Vasiljev:

- **Speech Highlights:** The speaker emphasized the project's objectives, the significance of TeM larvae in sustainable agriculture, and the collaborative efforts that made the initiative possible. They highlighted the training and capacity-building efforts and the expected positive impact on local farming practices.

2. Veterinum's CEO Dr Xemal Ravja:

- **Speech Highlights:** The CEO of Veterinum discussed the technical aspects of the breeding centre, the advanced infrastructure, and the role of Veterinum in local adaptation and production. They expressed gratitude to all partners and reaffirmed their commitment to the project's success.

3. TRISA Project Manager – MSc Pavle Varsaković:

- **Speech Highlights:** Project manager highlighted the alignment of the project with sustainable development goals and the ODA Challenge Call. They discussed the broader implications of the project for the region and

the potential for replication in other areas and benefits for agricultural holdings.

Media Coverage

The inauguration ceremony received extensive media coverage, ensuring widespread awareness and support for the TeM breeding initiative. Major media outlets and local news channels, including RTCG, covered the event, broadcasting key moments and interviews with stakeholders.

Media Highlights:

- **RTCG Coverage:** The national broadcaster RTCG aired a detailed segment on the inauguration, featuring interviews with key stakeholders and visuals of the facility. The coverage emphasized the project's innovative approach and its potential to transform local agriculture.
- **Local Newspapers and Online Portals:** Various local newspapers and online news portals reported highlighting the event, the project's objectives, and the expected benefits for the community.

The media coverage played a crucial role in promoting the TeM breeding initiative, garnering public interest and support, and highlighting the collaborative efforts of all partners involved. The positive response from the media and the community underscored the significance of the project and its potential impact on sustainable agriculture in Montenegro.



Site Inspection and Monitoring

Initial Inspections and Feedback

The initial inspection of the Tenebrio Molitor (TeM) Pilot Breeding Centre at Veterinum Headquarters in Ulcinj was conducted on April 22, 2024, by the expert team from Belinda Animals. This inspection was crucial to ensure that the facility met all the necessary standards for effective TeM larvae breeding.

Facility Description and Setup:

- The breeding room, measuring 30m², was designed to meet all the required conditions for larvae breeding. The room was fully isolated to minimize the risk of external contamination, with a dedicated entrance for staff access while maintaining biosecurity measures.
- The infrastructure included tiled floors and insulated walls, which facilitated easy cleaning, disinfection, and stable internal conditions. The facility was found to be clean and disinfected prior to use, meeting all sanitary standards.
- The room was equipped with a high-efficiency air conditioning system capable of controlling temperature and humidity. Smart sensors continuously monitored these environmental parameters, with automatic humidifying and temperature adjustment systems in place to maintain optimal conditions.

Equipment and Technology:

- The facility was furnished with specialized containers for different life stages of the larvae, feeding system, and waste collection units.
- Advanced sensors and control systems were installed to continuously monitor and adjust environmental conditions, ensuring the health and growth of the larvae.

Staffing and Training:

- Veterinum dedicated one agricultural expert and three staff workers for daily operations. Belinda Animals provided comprehensive training to both the management and operational staff, covering technical aspects of TeM breeding, operational protocols, and risk response measures.

Compliance and Best Practices:

- The setup of the Pilot Breeding Centre adhered to all applicable local and international standards for insect breeding. Procedures and setups were reviewed for compliance with local agricultural and biosecurity regulations, following industry best practices.

Initial Feedback:

- The inspection concluded that the facility setup, staff readiness, and technological integration were all in line with the standards required for such operations. Recommendations included continuous training for staff and ongoing monitoring of environmental conditions and larvae health to ensure any deviations were promptly addressed.

Ongoing Monitoring and Evaluations

Continuous monitoring and evaluation were integral to maintaining the high standards of the TeM breeding operations at the Veterinum Pilot Breeding Centre. This phase involved regular inspections, real-time monitoring of environmental conditions, and periodic assessments of staff performance and facility operations.

Facility Condition:

- The breeding facility remained in excellent condition, maintaining high cleanliness and hygiene standards. Additional measures, such as adding blackout material on windows, were implemented to maintain dark conditions favorable for larvae breeding and reduce temperature rise during sunny parts of the day.

Operational Systems:

- All installed systems, including temperature and humidity sensors, automatic humidifiers, and advanced monitoring equipment, functioned as intended. Real-time data monitoring provided accurate readings, facilitating prompt adjustments to maintain ideal breeding conditions. Key indicators such as temperature and humidity were monitored daily, consistently achieving optimal levels of 27-28°C and 55-60% humidity.

Staff Performance:

- The dedicated team at Veterinum demonstrated exceptional performance. Continuous mentoring and detailed training sessions conducted by Belinda Animals focused on advanced breeding techniques, environmental control, larvae care, and handling procedures. This enhanced the staff's capabilities, enabling them to manage increased production and maintain high standards of care.

Progress and Achievements:

- There was a significant increase in the number of TeM colonies, with over 10 new batches successfully established. This robust growth aligned with planned objectives and set a strong foundation for further expansion. The quality and health of the larvae were consistently high, thanks to precise environmental controls and diligent management by the staff.

Recommendations for Future Monitoring:

- Scaling up operations by expanding physical space and investing in advanced breeding and processing equipment.
- Continuous training and development for staff to stay updated with the latest breeding techniques and best practices.
- Exploring innovative techniques and technologies to improve breeding efficiency and larvae health, in collaboration with research institutions.
- Implementing sustainable practices in waste management and resource utilization to minimize environmental impact and enhance sustainability.

The ongoing monitoring and evaluations ensured that the Veterinum Pilot Breeding Centre operated at optimal efficiency and adhered to the highest standards. These efforts were instrumental in achieving the project's goals and laying the groundwork for future growth and success.

Production and Scaling

Current Production Levels and Achievements

The Veterinum Pilot Breeding Centre has reached a steady production level of approximately 100 grams of fresh *Tenebrio Molitor* (TeM) larvae per week. This production is currently used for experimental purposes, specifically in creating protein meals for feeding bees. These experiments aim to explore the nutritional benefits and potential of TeM larvae as a sustainable feed option.

Product Development:

- **Experimental Protein Meals for Bees:** Initial trials are promising, demonstrating the high protein content and suitability of TeM larvae for bee nutrition.
- **Future Products:** Plans are in place to develop additional TeM-based products, including oil and protein flour. These products are expected to provide versatile, sustainable alternatives for various agricultural applications.

Challenges and Solutions

Challenges:

1. **Environmental Control:** Maintaining consistent temperature and humidity levels in the breeding facility has been challenging, especially during seasonal changes.
2. **Production Scaling:** Increasing production capacity while maintaining quality and efficiency requires significant resource allocation and optimization.
3. **Market Acceptance:** Introducing new TeM-based products into the market and gaining acceptance among farmers and consumers involves extensive marketing and education efforts.

Solutions:

1. **Advanced Monitoring Systems:** The implementation of advanced climate control systems and real-time monitoring has helped mitigate environmental control challenges. Regular adjustments and maintenance ensure optimal conditions for larvae breeding.

2. **Process Optimization:** Continuous training and process optimization have been key to scaling production. The staff's enhanced skills and efficient operational practices have contributed to a steady increase in production capacity.
3. **Stakeholder Engagement:** Engaging with local farmers, agricultural professionals, and potential consumers through workshops, demonstrations, and promotional activities has been effective in building market acceptance. Collaborative efforts with research institutions also support the credibility and promotion of TeM-based products.

Plans for Scaling Up

Infrastructure Expansion:

- **Facility Enlargement:** Plans are underway to expand the physical space of the breeding centre to accommodate more breeding containers and increase production capacity.
- **Advanced Equipment:** Investing in additional advanced breeding and processing equipment to enhance efficiency and support larger-scale operations.

Research and Development:

- **Product Diversification:** Ongoing research aims to diversify the range of TeM-based products, focusing on developing high-quality oil and protein flour. These products are expected to open new market opportunities and provide additional revenue streams.
- **Innovative Techniques:** Exploring innovative breeding techniques and technologies to improve larvae health, productivity, and sustainability.

Market Strategy:

- **Marketing Campaigns:** Developing comprehensive marketing strategies to promote TeM-based products to farmers, agricultural businesses, and consumers. Highlighting the sustainability, economic benefits, and nutritional value of TeM larvae.

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- **Regulatory Compliance:** Working with governmental bodies to obtain necessary permits and certifications for new products. Ensuring all products meet regulatory standards and can be marketed legally and effectively.

Community Engagement:

- **Educational Programs:** Continuing to educate local farmers and stakeholders about the benefits and applications of TeM larvae through workshops, training sessions, and community events.
- **Partnerships:** Building partnerships with local agricultural businesses and research institutions to support the adoption and integration of TeM breeding into existing agricultural practices.

By addressing current challenges and implementing strategic plans for scaling up, the Veterinum Pilot Breeding Centre aims to significantly increase production capacity and market presence, contributing to sustainable agriculture and food security in the region.



Research and Development

Innovative Applications of TeM Larvae

The *Tenebrio Molitor* (TeM) larvae, known for their high protein content and sustainability, have vast potential for various innovative applications. Veterinum has been at the forefront of exploring these applications to enhance agricultural practices and develop new products.

Key Applications:

1. **Protein Meals for Bees:** One of the most promising applications is using TeM larvae protein in high-quality, natural protein meals for bees. This innovation aims to improve bee health and productivity, addressing a critical need in agriculture.
2. **Sustainable Animal Feed:** TeM larvae serve as an excellent alternative protein source for various livestock, contributing to more sustainable and cost-effective animal farming practices.
3. **Nutritional Supplements:** Developing nutritional supplements for pets and livestock that leverage the high protein and essential nutrient content of TeM larvae.

Ongoing Research Projects

Veterinum has initiated several research projects focused on maximizing the benefits of TeM larvae and integrating them into various agricultural practices.

Current Research Initiatives:

1. **Bee Nutrition:** Ongoing trials are examining the impact of TeM larvae protein on bee health and productivity. Preliminary results are promising, showing improvements in bee vitality and honey production.
2. **Product Development:** Research is being conducted to develop TeM-based products such as oil and protein flour. These products are aimed at providing versatile, sustainable options for the agricultural and food industries.
3. **Waste Management:** Investigating the efficiency of using organic waste for TeM larvae breeding, contributing to a circular economy and reducing environmental impact.

Collaboration with Research Institutions

Collaboration with research institutions is a cornerstone of the Veterinum Pilot Breeding Centre's approach to research and development. These partnerships enhance the project's credibility and facilitate the exchange of knowledge and expertise.

Collaborative Efforts:

1. **Academic Partnerships:** Working with universities and research institutions to conduct rigorous scientific studies on the nutritional and environmental benefits of TeM larvae. These collaborations provide valuable data and insights that drive innovation and product development.
2. **Industry Collaborations:** Partnering with industry leaders in agriculture and food production to explore commercial applications of TeM larvae. These collaborations help in scaling up production and bringing new products to market.
3. **Government and Regulatory Bodies:** Engaging with government agencies to ensure compliance with regulatory standards and obtain necessary permits for new products. These partnerships are crucial for market acceptance and legal compliance.

By leveraging the innovative potential of TeM larvae, ongoing research projects, and strategic collaborations, the Veterinum Pilot Breeding Centre is poised to lead the way in sustainable agricultural practices and product innovation. These efforts contribute to the broader goals of enhancing food security, promoting environmental sustainability, and driving economic growth in the agricultural sector.

Market and Economic Impact

Market Analysis and Opportunities

The introduction of *Tenebrio molitor* (TeM) larvae as an alternative animal feed in the Balkan region presents numerous market opportunities. TeM larvae offer a sustainable and efficient alternative to traditional animal feeds, aligning with the rising global demand for environmentally friendly and resource-efficient solutions. In Montenegro and the broader Balkan region, several key factors highlight the market potential:

1. Sustainable Agriculture and Circular Economy:

- **Sustainability:** TeM larvae can be produced using significantly less water, land, and feed compared to conventional livestock feed sources like soy and fishmeal. This efficiency makes TeM larvae a highly attractive option for sustainable agriculture practices .
- **Waste Reduction:** The larvae can thrive on organic waste streams such as agricultural by-products and food waste, contributing to a circular economy by turning waste into valuable feed. This reduces the environmental footprint of food production and aligns with global sustainability goals.

2. Alternative Protein Source:

- **Nutritional Value:** TeM larvae are rich in protein, essential amino acids, and fatty acids, making them a competitive alternative to traditional protein sources. This positions them as an excellent feed option for livestock, poultry, and aquaculture .
- **Market Readiness:** There is growing interest among farmers and feed producers in the Balkan region for sustainable feed alternatives. However, educational campaigns and demonstrations are necessary to overcome initial unfamiliarity and skepticism .

3. Economic Viability and Cost Reduction:

- **Cost-Effective Production:** The cultivation of TeM larvae can be economically advantageous due to low operational costs and high yield

potential. This can lead to significant cost savings for farmers, especially in regions where traditional feed prices are high or volatile .

- **Economic Benefits:** Using locally produced larvae feed can reduce dependency on imported feeds, stabilizing prices and ensuring a reliable supply chain. This is particularly beneficial in the context of the Balkan agricultural market, which faces challenges related to feed costs and supply reliability .

Economic Benefits and Cost Savings

The economic impact of integrating TeM larvae into the agricultural sector extends beyond cost savings. The benefits encompass improved profitability for farmers, enhanced livestock productivity, and contributions to local economies:

1. Reduction in Feed Costs:

- **Affordable Alternative:** TeM larvae offer a more affordable alternative to traditional feeds, potentially reducing feed costs significantly. This economic advantage is crucial for farmers dealing with rising costs of conventional feeds .

2. Improved Livestock Productivity:

- **Enhanced Health and Yield:** The high nutritional value of TeM larvae can improve the health and productivity of livestock, leading to better growth rates and higher yields. This not only enhances farm profitability but also improves the quality of animal products such as meat, eggs, and milk .

3. Local Economic Development:

- **Job Creation and Business Opportunities:** The establishment of TeM larvae production facilities can create new jobs and business opportunities within local communities. This includes roles in production, processing, and distribution of larvae-based products .

Case Studies and Success Stories

1. Veterinum Pilot Breeding Center:

- **Success Story:** The establishment of the Veterinum Pilot Breeding Center in Ulcinj serves as a successful case study. The center has demonstrated the feasibility and benefits of TeM larvae production, including significant increases in larvae batches and successful integration into experimental protein meals for bees .
- **Practical Demonstrations:** Practical training sessions and workshops have been held at the center, showcasing the entire breeding process and the practical applications of TeM larvae. These sessions have been well-received by local farmers, agricultural experts, and government representatives, highlighting the potential for wider adoption and scaling .

2. Local Government Initiatives:

- **Policy Support:** Local government representatives have shown interest in supporting further development of TeM larvae production as part of broader sustainable agriculture initiatives. This support includes exploring regulatory frameworks, providing incentives, and integrating TeM larvae into local agricultural practices.

By leveraging these market opportunities and addressing economic benefits and challenges, TeM larvae can significantly impact the agricultural sector in the Balkans, promoting sustainability, efficiency, and economic resilience.

Stakeholder Feedback

Summary of Feedback from Veterinum Crew

The Veterinum crew, including both the agricultural expert and the operational staff, provided detailed feedback on their experience with the TeM Breeding Initiative. Their motivation primarily stemmed from the opportunity to enhance their skills and contribute to an innovative agricultural project.

Key Insights:

- **Skill Enhancement:** The comprehensive training sessions significantly improved their understanding of TeM breeding techniques and environmental controls. The hands-on approach helped them apply theoretical knowledge in practical settings.
- **Operational Efficiency:** Staff reported increased confidence in managing the breeding process, thanks to the detailed training on larvae care and environmental management. The knowledge gained has enabled them to troubleshoot issues more effectively and optimize operations.
- **Continued Involvement:** The crew expressed a strong interest in staying involved with the project, suggesting the development of additional training programs and advanced modules to further enhance their expertise.

Insights from Veterinarians

Veterinarians involved in the project provided valuable insights, highlighting the potential benefits of TeM larvae in sustainable agriculture and animal nutrition.

Key Insights:

- **Nutritional Benefits:** Veterinarians were particularly interested in the high protein content and nutritional value of TeM larvae. They noted the potential for TeM larvae to improve the health and productivity of various livestock.
- **Innovative Applications:** The research into using TeM larvae protein in bee nutrition was especially intriguing. Veterinarians appreciated the innovative approach and the potential to address nutritional deficiencies in bees.

- **Support for Further Research:** There was a strong recommendation to continue and expand research on TeM larvae applications, particularly in developing high-quality, natural protein feeds for different animals.

Perspectives from Small Farm Representatives

Representatives from small farms participated actively in the training sessions and provided feedback on how they could integrate TeM breeding into their own operations.

Key Insights:

- **Practical Application:** The hands-on demonstrations and practical training sessions were highly valued. Small farm representatives felt confident in applying the techniques learned to start their own TeM breeding operations.
- **Cost Savings:** Many highlighted the potential economic benefits, such as reduced feed costs and the ability to produce high-quality protein feed locally. This was seen as a significant advantage for small-scale farmers looking to reduce expenses and improve profitability.
- **Interest in Adoption:** Several representatives expressed interest in starting small TeM breeding operations on their farms. They saw this as an opportunity to diversify their agricultural activities and enhance sustainability.

Views from Local Government Officials

Local government officials, who deal with agricultural policies and development, provided feedback on the broader implications of the TeM Breeding Initiative.

Key Insights:

- **Policy Alignment:** The officials appreciated how the project aligned with local and national agricultural policies aimed at promoting sustainability and food security. They recognized the potential of TeM larvae to contribute to these goals.
- **Support for Expansion:** There was strong support for expanding the project and integrating TeM breeding into broader agricultural practices. Officials suggested developing further programs and incentives to encourage adoption among local farmers.

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- **Regulatory Compliance:** The importance of ensuring regulatory compliance was emphasized. Officials expressed willingness to assist in navigating regulatory frameworks and obtaining necessary permits to facilitate the project's growth.

The stakeholder feedback highlighted the positive impact of the TeM Breeding Initiative across different groups. The Veterinum crew benefited from enhanced skills and operational efficiency, veterinarians appreciated the nutritional and innovative potential of TeM larvae, small farm representatives saw practical and economic advantages, and local government officials supported the project's alignment with policy goals. This collective feedback underscores the importance and potential impact of the project, providing a strong foundation for its continued success and expansion.



Future Plans and Recommendations

Strategic Vision for the Future

The Tenebrio Molitor (TeM) Breeding Initiative at the Veterinum Pilot Breeding Centre has demonstrated significant potential for addressing critical challenges in food security, sustainable agriculture, and waste management. The strategic vision for the future involves scaling up operations, expanding the range of TeM-based products, and transferring this successful model to other regions.

Strategic Goals:

- **Scaling Production:** Increase the production capacity of TeM larvae to meet the growing demand for sustainable animal feed and other applications.
- **Product Development:** Diversify the product portfolio to include TeM-based oil, protein flour, and nutritional supplements for various agricultural and industrial applications.
- **Technology Transfer:** Utilize the successful implementation of the TeM breeding technology as a model for transfer to other regions, particularly in the Western Balkans, under the Official Development Assistance (ODA) framework.

The ODA Challenge Call, supported by the UNDP and the Government of Serbia, aims to foster the transfer of innovative solutions to address developmental challenges in North Macedonia, Albania, Montenegro, and Bosnia and Herzegovina. The TeM Breeding Initiative is an exemplary case of how local innovations can be adapted and scaled to solve regional and global problems.

Recommendations for Continuous Improvement

To ensure the sustained success and growth of the TeM Breeding Initiative, several recommendations have been identified:

1. Enhanced Training Programs:

- Develop advanced training modules focusing on new technologies and methodologies in TeM breeding.
- Organize regular refresher courses and workshops to keep staff updated on best practices and innovations.

2. Infrastructure Upgrades:

- Invest in additional breeding and processing equipment to increase efficiency and capacity.
- Implement advanced monitoring and automation systems to ensure optimal breeding conditions and reduce manual labor.

3. Research and Development:

- Continue exploring innovative applications of TeM larvae, particularly in high-value markets such as pharmaceuticals, cosmetics, and bio-fertilizers.
- Collaborate with academic and research institutions to conduct studies on the nutritional and environmental benefits of TeM larvae.

4. Market Expansion:

- Develop comprehensive marketing strategies to promote TeM-based products to a broader audience, highlighting their sustainability and economic benefits.
- Establish partnerships with local and international agricultural companies to facilitate market entry and expansion.

Potential Areas for Expansion

The success of the TeM Breeding Initiative in Montenegro provides a solid foundation for expansion into other regions. Key areas for potential expansion include:

1. Western Balkans:

- **North Macedonia and Albania:** Leverage existing partnerships and the framework provided by the ODA Challenge Call to replicate the TeM breeding model. This will involve establishing pilot centres, training local staff, and adapting the technology to local conditions.
- **Bosnia and Herzegovina:** Explore opportunities for collaboration with local agricultural institutions and businesses to introduce TeM larvae

breeding as a sustainable solution for animal feed and waste management.

2. Southeastern Europe:

- Utilize the success stories and case studies from the Balkans to promote TeM breeding in other Southeastern European countries. This will involve conducting feasibility studies, establishing local partnerships, and securing funding through international development programs.

3. Global Outreach:

- Position the TeM Breeding Initiative as a model for sustainable agriculture that can be adapted to various global contexts. Engage with international organizations, NGOs, and development agencies to facilitate knowledge transfer and support for scaling the initiative globally.

By focusing on continuous improvement, strategic expansion, and leveraging the support of initiatives like the ODA Challenge Call, the TeM Breeding Initiative is well-positioned to make a substantial impact on sustainable agriculture and food security, both regionally and globally.

Conclusion

Recap of Achievements

The *Tenebrio Molitor* (TeM) Breeding Initiative at the Veterinum Pilot Breeding Centre has successfully met its objectives and demonstrated significant achievements in the realm of sustainable agriculture and food security. Key accomplishments include:

- **Infrastructure Setup and Operations:** Established a breeding facility equipped with advanced climate control systems and specialized breeding equipment.
- **Training and Capacity Building:** Conducted comprehensive training sessions for Veterinum staff, local farmers, and agricultural workers, enhancing their skills and knowledge in TeM breeding.
- **Production and Scaling:** Successfully increased production capacity to approximately 100 grams of fresh larvae per week, with plans to develop additional TeM-based products such as oil and protein flour.
- **Research and Development:** Initiated innovative research projects, including the use of TeM larvae protein in high-quality, natural protein meals for bees, showcasing the potential of TeM larvae in diverse agricultural applications.
- **Stakeholder Engagement:** Engaged a wide range of stakeholders, including veterinarians, small farm representatives, and local government officials, ensuring broad-based support and collaboration.

Long-term Impact

The long-term impact of the TeM Breeding Initiative is far-reaching, offering sustainable solutions to key agricultural challenges in the Balkan region and beyond:

- **Sustainable Agriculture:** By providing an alternative protein source, the project promotes sustainable agricultural practices, reduces reliance on traditional feeds, and contributes to environmental conservation.
- **Economic Benefits:** The cost savings and revenue generation potential from TeM larvae production enhance the economic stability of local farmers and agricultural businesses.

- **Food Security:** The initiative supports local food security by providing a reliable, sustainable protein source and reducing the environmental footprint of food production.
- **Technological Transfer:** The project serves as a model for the successful transfer of technology, demonstrating how innovative solutions can be adapted and scaled to address regional and global challenges.

Acknowledgments

The success of the TeM Breeding Initiative would not have been possible without the dedication and collaboration of numerous partners and stakeholders:

- **Veterinum:** The main project partner, whose expertise in specialized animal feed and commitment to innovation have been instrumental in the project's success. Their active involvement in local adaptation, production, and distribution has laid a strong foundation for future growth.
- **Belinda Animals:** Provided technical expertise, comprehensive training, and continuous support, ensuring the effective transfer of technology and best practices.
- **United Nations Development Programme (UNDP):** Supported the project through the ODA Challenge Call, providing critical financial support and strategic oversight.
- **Local Farmers and Agricultural Workers:** Their active participation and feedback have been invaluable in shaping the project and ensuring its practical relevance and impact.
- **Local Government Officials:** Facilitated regulatory compliance and provided support for integrating the project into local agricultural policies.

The partnership between Veterinum and the project team has been a cornerstone of the initiative's success. This collaboration has not only achieved the project's immediate goals but also laid the groundwork for future initiatives. Plans are already underway to implement further technology and expand the project to Albania, leveraging the close connections and collaborative spirit fostered by Veterinum.

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The detailed plan for technology transfer to Albania includes establishing pilot breeding centers, training local staff, and adapting the TeM breeding model to local conditions. This initiative aims to replicate the success seen in Montenegro and contribute to sustainable agricultural practices across the region.

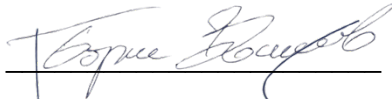
In conclusion, the TeM Breeding Initiative stands as a testament to the power of innovation, collaboration, and strategic planning in addressing some of the most pressing challenges in agriculture today. The project's achievements and long-term impact promise a brighter, more sustainable future for the agricultural sector in the Balkans and beyond.

In Belgrade,

05.07.2024.

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