REPIC

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Federal Office for the Environment FOEN

Swiss Federal Office of Energy SFOE

Final Report:

Solar Mushroom Farm

Sustainable mushroom farming in Tanzania

Author(s):
Markus Parzefall, Power-Blox AG
Gian Schachenmann, Fungitamu
Alessandro Medici, Power-Blox AG

Date of the Report: 10.10.24	Contract Number: 2022.08
Institution: Power-Blox AG	Country: Tanzania

Prepared by:

Power-Blox AG
Hauptstrasse 44, CH-5070 Frick
info@power-blox.com / www.power-blox.com

Fungitamu
PO Box 117, Arusha Main, Tanzania

With the support of:
REPIC Platform
c/o NET Nowak Energy & Technology Ltd.
Waldweg 8, CH-1717 St. Ursen
Tel: +41(0)26 494 00 30, Fax: +41(0)26 494 00 34, info@repic.ch / www.repic.ch

The REPIC Platform is a mandate issued by the:
Swiss State Secretariat for Economic Affairs SECO
Swiss Agency for Development and Cooperation SDC
Federal Office for the Environment FOEN
Swiss Federal Office of Energy SFOE

The author(s) are solely responsible for the content and conclusions of this report.

REPIC

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Federal Office for the Environment FOEN

Swiss Federal Office of Energy SFOE

Contents

1. Summary 4
2. Starting Point 4
3. Objectives 5
4. Project Review 6
   - 4.1 Project Implementation 6
   - 4.2 Achievements of Objectives and Results 8
   - 4.3 Multiplication / Replication Preparation 10
   - 4.4 Impact / Sustainability 10
5. Outlook / Further Actions 12
   - 6.1 Multiplication / Replication 12
   - 6.2 Impact / Sustainability 13
7. Lessons Learned / Conclusions 14

1. Summary

The Solar-Powered Mushroom Farm project was initiated to address critical challenges in Tanzania's agricultural sector, particularly in the underserved mushroom market. In Tanzania, the majority of mushrooms are imported from Kenya, with local production mostly being limited to a single variety. This reliance on imports not only increases costs for local consumers, particularly in the tourism sector, but also represents a missed opportunity for local farmers to generate income. Additionally, the unreliable power supply in Tanzania in general and in the Arusha region in particular poses a significant barrier to consistent agricultural production.

To address these needs, the project implemented a solar-powered mushroom farm designed to sustainably produce a variety of edible mushrooms. The farm consists of two grow rooms and two incubation rooms housed in modified shipping containers. The farm is powered by a 27 kWp solar photovoltaic (PV) system combined with a 40 kWh LFP battery storage, which ensures a reliable power supply for the farm's operations.

The project was carried out in multiple phases. It began with detailed planning, procurement of necessary materials, and construction of the farm infrastructure. Following this, the solar PV and battery systems were installed and commissioned. Mushroom cultivation commenced in November of 2023, initially focusing on several varieties of oyster mushrooms. The farm has achieved a stable production level of 50 kg of mushrooms per week within the first year of operations. The mushrooms have been successfully sold in fresh and dried form under the newly created brand "Fungitamu", derived from the words "fungi" for mushrooms and "tamu", the Swahili word for "delicious", c.f. logo on the front page.

The primary objectives of the project—to establish a sustainable mushroom farm, trial different cooling systems, and create new income opportunities for local farmers—have been successfully met. The farm employs two full-time staff members and provided training to ensure the sustainability of operations.

Looking ahead, the project aims to expand production and fully explore the local market potential. Future actions include increasing marketing efforts to drive demand, scaling up production to meet larger orders expected during the peak safari season, and implementing a franchising model to facilitate the replication of this successful business model across Tanzania and other countries.

2. Starting Point

At the start of the Solar Mushroom Farm project and still today, Tanzania's mushroom market is largely underdeveloped, despite the growing demand for local and healthy food options. The existing local production was limited to a single variety of oyster mushroom, which had a short shelf life and was primarily consumed by local communities. This limited production meant that the tourism sector, a significant contributor to Tanzania's GDP, had to rely heavily on imported mushrooms from Kenya, Asia, and Europe. These imports not only increased costs for local businesses but also contributed to higher carbon emissions due to long-distance transportation. The market gap was clear, with an unmet demand for high-quality, locally produced mushrooms, particularly from lodges and camps catering to tourists.

Recognizing this opportunity, the project was conceived with the goal of establishing a sustainable, solar-powered mushroom farm that could produce a variety of mushrooms locally. The project's innovative approach involved using three 40-foot containers to house the entire infrastructure necessary for mushroom cultivation, including specialized rooms for incubation, pasteurization, inoculation, and processing. A key feature of the project was the integration of a

solar-powered energy system designed to overcome the challenges posed by Tanzania's unreliable power grid.

The project was designed not only to meet local demand but also to empower rural farmers by providing them with a new source of income. By using simple, locally available materials, the farm's infrastructure was created to be easily replicable, promoting scalability and sustainability. The project also had strong backing from local stakeholders, which confirmed significant demand from the tourism industry. Several lodges in the Arusha region expressed their willingness to purchase locally grown mushrooms, providing a solid commercial foundation for the project.

Prior to the full-scale implementation, our local project partners had already achieved initial successes with experimental mushroom cultivation facilities. These early experiments demonstrated the viability of the project concept and provided the confidence needed to scale up.

3. Objectives

The Solar Mushroom Farm project was designed with three primary objectives, each tailored to address specific challenges and opportunities in Tanzania's agricultural sector, particularly in the realm of mushroom cultivation and sustainable energy use.

Objective 1: Demonstration of the Solar-Based Mushroom Cultivation Business Model

The first objective was to establish and demonstrate a viable business model for solar-powered mushroom cultivation. This involved expanding small experimental facilities into a fully operational production plant housed in three 40-foot containers—two designated for mushroom fruiting and one for incubation. The goal was to achieve appealing production quantities, targeting a monthly output of 200-300 kg per container, with an overall production capacity of 400-600 kg of mushrooms per month (90-140 kg per week). Given that edible mushroom cultivation is a relatively new field in Tanzania, a key aspect of this objective was to investigate and validate the entire value chain, from cultivation to market, through practical testing. The project aimed to meet the demand expressed in letters of intent from potential customers, who had shown interest in purchasing fresh edible mushrooms. Additionally, the facility was intended to serve as a research base to identify market needs, provide training for local farmers, and produce high-quality mushroom spawn (seeds) for distribution to farmers interested in entering this market.

Objective 2: Compare Solar Direct Cooling and Mini-Grid Based Cooling

The second objective focused on the technological aspect of mushroom cultivation, specifically the cooling systems necessary for maintaining optimal growing conditions. Recognizing the central role that cooling plays in the food value chain, the project sought to gain experience with solar-powered cooling technologies, which are crucial for agricultural products like mushrooms. The project aimed to directly compare two methods of cooling: solar direct cooling, which utilizes thermal energy stored as ice to minimize the need for chemical storage in batteries, and conventional split-phase cooling systems powered by the solar battery system. This comparison was intended to assess the simplicity of setup, cost, efficiency, applicability, reliability, maintenance needs, and overall suitability for mushroom cultivation. The ultimate goal was to identify a scalable and cost-effective cooling solution that could be easily replicated as part of the broader mushroom cultivation model.

Objective 3: Create an Alternative Income and Food Source for Farmers in Tanzania

The third objective was to develop an alternative source of income and food for Tanzanian farmers, particularly in the face of the challenges posed by climate change. The project aimed to introduce mushrooms as a drought-resistant crop that could be cultivated on a wide variety of agricultural waste materials, such as sugar cane bagasse, rice straw, wheat straw, bean husks, and banana leaves. This approach not only provided a high-yield, nutritious food source that

requires minimal water and is resilient to climate fluctuations, but also offered a sustainable way to utilize agricultural by-products. By integrating mushroom cultivation into existing farming practices, the project sought to empower local farmers, diversify their income streams, and enhance food security in the region.

These objectives were integral to the project's vision of combining innovative solar technology with sustainable agricultural practices to create a replicable model for economic and environmental resilience in Tanzania.

4. Project Review

4.1 Project Implementation

The Solar Mushroom Farm project was carried out in a series of phases, involving close collaboration between Power-Blox AG and our local partners Gian Schachenmann and Enda Solar Ltd.. The project began with the detailed design and planning of the mushroom cultivation facility, which was to be housed in three 40-foot containers. These containers were repurposed to include specialized areas for mushroom incubation, fruiting, and processing, all powered by a solar photovoltaic (PV) system designed to ensure a reliable energy supply despite the region's frequent power outages.

Approach and Key Steps

The initial phase of the project focused on finalizing the proposed design of the solar energy and cooling systems, which were central to maintaining the controlled environment necessary for mushroom cultivation. Procurement of materials was completed in Europe, Tanzania and Kenya, with components including batteries, solar panels, inverters, and cooling systems sourced and shipped to Tanzania. Despite global supply chain disruptions that caused delays, particularly in the delivery of inverters, all necessary materials were on-site by end of July 2023.

Figure 1: Solar battery system. Top: Inverter and battery installation in underground room. Bottom: Picture of solar PV array on roof of solar mushroom farm.

Construction of the mushroom farm began with the excavation and preparation of the site in Arusha, where the containers were installed. The facility was equipped with a solar PV system with a capacity of 27 kWp and a battery storage capacity of 40 kWh, c.f. Figure 1, supplying up to 16 kVA of continuous power to ensure that the energy needs of the farm could be met. The first grow room and incubation room became operational in November 2023, marking the beginning of mushroom production on a larger scale.

Cultivation and Production

By January 2024, the farm had started producing significant amounts of mushrooms. As part of the project's approach to scalability and sustainability, two full-time staff members were hired and trained in February 2024, and additional casual labor was brought in as needed to manage the growing workload. By April 2024, the farm was fully operational with two grow rooms and two incubation rooms.

Plastic buckets were used as grow containers. These buckets, which are recyclable and easy to handle, proved to be highly effective in achieving impressive yields. The farm's production process has not yet reached its full potential, as the team continues to test the market and refine their operations. However, initial feedback from local lodges and camps has been overwhelmingly positive. The local market has also shown strong interest in fresh oyster mushrooms, although further marketing efforts are planned to fully explore this potential.

Modifications to Project Objectives

Throughout the project's implementation, the main objectives remained largely unchanged, although some adjustments were made in response to operational challenges and market feedback. The most significant modification involved the timeline, which was extended due to delays in the procurement of critical components, particularly inverters, caused by global supply chain issues.

Additionally, while the primary focus remained on fresh mushroom production, the project team has also begun experimenting with drying mushrooms as a value-added product. This decision was driven by the need to diversify the farm's offerings and explore new market opportunities, ensuring that the project's business model remains resilient and adaptable. It further allows the farm to continue production at full capacity even during the low season when demand for fresh mushrooms is reduced.

Overall, the project has successfully navigated these challenges, and the farm is now on track to meet its production and market goals. The experience gained in the first phase of operations has provided valuable insights that will guide future scaling and replication efforts, both within Tanzania and potentially in other regions.

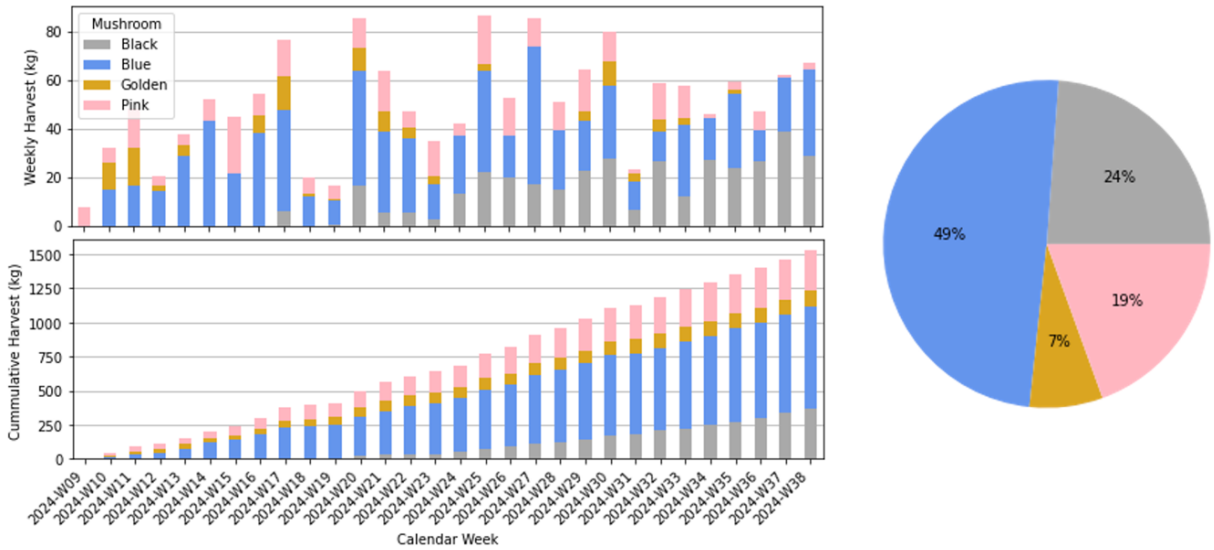

Figure 2: Mushroom production output of the farm. Left: Weekly harvest from week 9 to 38 of 2024 as well as cummulative harvest. Right: Pie chart showing the distribution of harvested mushroom across the different varieties.

Figure 3: From growth to sales. Photographs showing the growth of mushrooms in the containers (left, center top), harvested mushrooms (center bottom) as well as fresh and dried (right, bottom and top, respectively) mushrooms, packaged, labeled, and ready to sell.

4.2 Achievements of Objectives and Results

The Solar Mushroom Farm project has achieved its primary objectives, with the key milestones having been met and promising results continuously emerging from the ongoing operations.

Objective 1: Demonstration of the Solar-Based Mushroom Cultivation Business Model

This objective has been successfully achieved through the establishment of a fully operational mushroom farm in Arusha, Tanzania. Until now primarily one growth room has been used as the market is still evolving, different mushrooms are trialed and the growth process optimized. Current production levels for a single growth room are about 50 kg of mushrooms, c.f. Figure 2, and about 28 kg of mushroom seeds per week. About 160 kg of chopped maize is used as primary growth medium per week. The farm focused on cultivating several varieties of oyster mushrooms, including blue, pink, black, and yellow/gold. With the second growth room beginning operations in the coming weeks, the target production capacity of 90-140 kg of mushrooms per week is well within reach as the farm continues to optimize its operations. Until today, more than 1’500 kg of mushrooms were grown and sold, c.f. Figure 2 and Figure 3.

The facility has demonstrated the feasibility of using solar power as the primary energy source for mushroom cultivation, even in a region with an unreliable power grid. Since reaching a production capacity of 50kg per week in April of 2024 the farm uses around 40 to 50 kWh per day, see Figure 4. The majority of electricity is supplied by the solar battery system with about 38% of consumption being covered directly by the PV system, around 56% of electricy by energy from the PV installation, intermediately stored in the batteries and a total of only 7% being supplied by the public grid, mostly during extended bad weather periods with reduced solar production. Finally, the farm has begun generating revenue, with sales prices reaching an average of around 45’000 Tanzanian Shillings / kg (14 CHF / kg) which is significantly higher than originally anticipated. Until now the farm has not generated significant profits as costs for operations, especially raw materials, labor, packaging, transport and distribution, are higher than anticipated. However, considering that the farm has only been operating for one year this is still a positive result as we expect the output of the farm to grow signifcantly with the second growth room

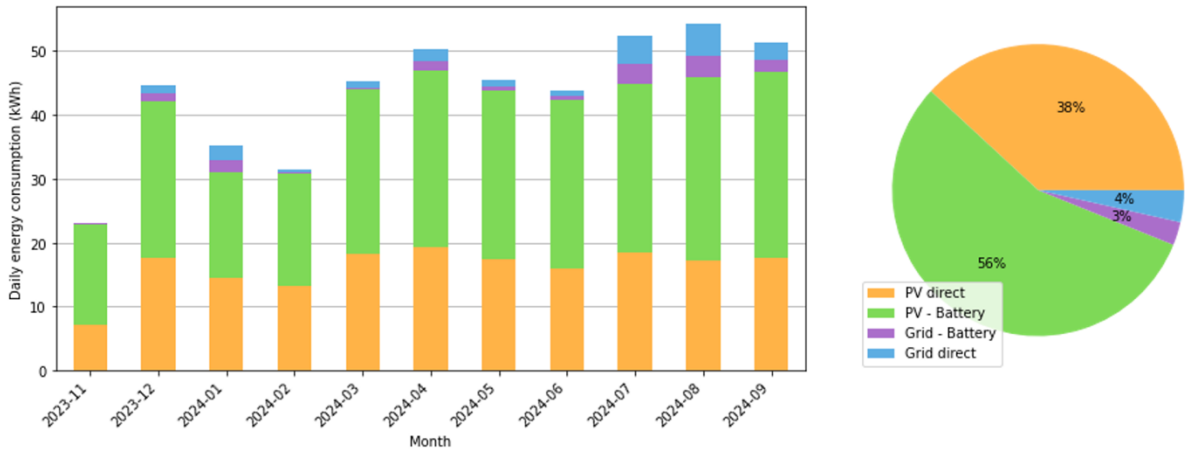

Figure 4: Electricity consumption of the solar mushroom farm. Left: Monthly averages of the daily electricity consumption. Right: Distribution of electricity consumption by origin.

entering operationand the growth process continuously being optimized, marketing and sales being improved throughout the season and with growing customer interest and confidence.

Objective 2: Compare Solar Direct Cooling and Mini-Grid Based Cooling

The project made substantial progress in achieving this objective, particularly with the implementation and testing of the solar direct cooling system. This system, designed to store thermal energy as ice, was successfully installed and trialed. However, the results were mixed. While the system functioned as intended from a technical standpoint, the overall energy efficiency and cooling power were found to be insufficient to maintain the temperature conditions required for the inoculation and growth rooms. While efforts are ongoing to improve the performance, e.g. by adjusting the size of the heat exchanger and improving insulation of the piping, the current performance suggests that the solar direct cooling system may be better suited for applications such as cold storage of fresh produce.

For now, we have transitioned to using standard split-phase units powered by the mini-grid for cooling the inoculation room and one of the growth rooms. This solution has proven more effective in controlling the temperature, as the cooling energy is generated close to the areas that require it, reducing losses during energy transfer. However, this approach is not without its challenges. The temperature control of the growth room, in particular, remains energy-intensive, as it requires frequent air exchanges to regulate the conditions, and the growing mushrooms themselves generate additional heat. To address these challenges, we are continuously working on improving the overall energy efficiency of the farm. This includes exploring alternative methods of environmental control. One promising finding from our trials is that regulating humidity alone, may be sufficient for certain types of mushrooms. Our current approach is to continue growing mushrooms with both temperature and humidity control in the first growth room and trial growth with humidity control only in the second growth room.

Objective 3: Create an Alternative Income and Food Source for Farmers in Tanzania

The project has successfully introduced mushroom cultivation as a viable and profitable agricultural practice in Tanzania. By utilizing agricultural waste products such as chopped maize, the farm has established a sustainable production cycle that requires minimal water and is resilient to climate variability. The employment of two full-time staff members, along with additional casual workers, underscores the project's impact on local job creation and economic development. In the long run, when reaching full production capacity, we anticipate that three full-time staff members and two casual workers will be employed by the farm.

Furthermore, the farm's operations have begun to attract significant interest from local markets, particularly within the tourism sector, which is expected to materialize even more in the next high season. This growing demand highlights the potential for mushroom cultivation to become a stable and lucrative income source for local farmers, contributing to enhanced food security and economic resilience in the region.

Overall Results

Overall, the project has achieved its primary objectives to a considerable extent. The successful establishment and operation of the mushroom farm, the implementation and testing of solar cooling technologies, and the creation of new economic opportunities for local farmers are clear indicators of the project's success. While there is still work to be done in fully realizing the farm's production potential, expanding market reach and improving the profit margin, the initial results are highly encouraging. The project's impact on the local community, both economically and socially, is already evident, and the groundwork has been laid for future expansion and replication across Tanzania and potentially other regions in East Africa.

4.3 Multiplication / Replication Preparation

Several preparatory steps were taken within the project framework to facilitate future multiplication and replication of the solar-powered mushroom farm model across Tanzania and other regions.

One of the first steps was designing the farm's infrastructure to be easily replicable. The use of standard 40-foot containers and locally available materials, such as plastic buckets for growing containers and agricultural waste as a growth medium, allows the model to be applied in areas with limited resources or infrastructure. By relying on these simple, cost-effective solutions, the farm can easily be replicated.

The project also developed a practical and scalable energy solution. The solar battery system provides a reliable and efficient power source that can be easily adapted to other regions with similar energy challenges. By testing both solar direct cooling and mini-grid cooling systems, the project has gained valuable insights into which technologies are most suitable for different contexts.

Furthermore, the farm has produced high-quality mushroom spawn (seeds), which are essential for any future replication efforts. These spawn can be sold to other farmers who wish to enter the mushroom cultivation business, allowing them to start production without needing to rely on expensive imports.

Finally, the project has established strong links with the local market, particularly within the tourism sector, which has shown significant interest in purchasing locally grown mushrooms. This demand, coupled with the project's ability to produce a reliable supply of mushrooms, lays the foundation for successful replication of the model by other farmers and entrepreneurs.

4.4 Impact / Sustainability

By the end of the project, several tangible impacts had been observed across ecological, economic, and social dimensions.

Ecological Impact

The implementation of the solar-powered system has significantly reduced the farm's reliance on the grid, helping to decrease fossil fuel consumption and lower greenhouse gas emissions. Here are the quantifiable ecological impacts:

Ecological	Unit	At the REPIC Project's Completion
Installed renewable energy capacity	[kWp]	27
Renewable energy produced	[kWh]/year	16'200
Amount of fossil fuel energy saved	[kWh]/year	10'8501
Greenhouse gas reduction	[t CO2-eq]/year	5.52

The solar system has not yet fully reached its maximum electricity production potential as the farm has not yet reached full production capacity. We also further work to optimize the ratio between daytime and nighttime consumption to increase solar energy consumption and ease the burden on the battery storage system.

Economic Impact

The farm has proven to be economically viable, generating revenue and showing great promise with regards to profit generation from mushroom sales. The project has also created new jobs and contributed to local income generation.

Economic Impact	Unit	At the REPIC Project's Completion
Mushrooms produced	[kg]	1'500
Mushroom sales	[CHF]	21'000

Social Impact

The project has had a notable social impact by creating jobs and providing training to local workers. As mushroom cultivation expands, more local farmers will benefit from increased employment opportunities and new sources of income.

Social Impact	Unit	At the REPIC Project's Completion
Number of beneficiaries	[Number]	2 full-time employees + casual workers
Number of new jobs	[Number]	2 full-time jobs
Number of trained personnel	[Number]	2

[1] 67% (2022) of electricity generation in Tanzania is from fossil fuels. Source: https://ourworldindata.org/electricity-mix

[2] Carbon intensity of electricity generation in Tanzania: 0.339 gCO2-eq/kWh. Source: https://ourworldindata.org/grapher/carbon-intensity-electricity

5. Outlook / Further Actions

6.1 Multiplication / Replication

The next phase of the project focuses on reaching full production capacity, improving growth processes, enhancing marketing and sales, and eventually scaling up the production model across other regions of Tanzania and potentially throughout East Africa. Several steps have already been initiated to support the multiplication and replication of the solar-powered mushroom farm concept.

Franchising Model

A key strategy for scaling the project involves developing a franchising model that allows local entrepreneurs to replicate the solar-powered mushroom farm using a standardized infrastructure and production methods. This model will be built around providing franchisees with detailed technical guidance, blueprints for infrastructure setup, and access to high-quality spawn produced by the central farm. Additionally, franchisees will receive ongoing market support, leveraging the established brand's reputation and network, particularly within the tourism and hospitality sectors.

To ensure the success of the franchising model, we will adopt a "turnkey" approach, where franchisees are provided with everything they need to launch their own farm. This includes not just the spawn and the infrastructure blueprints, but also training in solar energy management, mushroom cultivation techniques, and post-harvest processing. By consolidating the brand and setting high standards for quality and operational efficiency, the franchise model will help ensure consistency across multiple locations, enhancing market recognition and trust in the product.

Financing the initial infrastructure for these farms will be the biggest hurdle in scaling the model. To address this challenge, we have identified two promising financing solutions:

*Impact Investors and Crowd Financing***:** The environmental sustainability of the solar-powered farms makes them attractive to impact investors and crowd financing platforms. We are seeking partnerships with international and local impact investment funds that provide capital specifically for projects that generate both economic and environmental benefits. These funds could offer upfront financing for franchisees in exchange for equity or a share of the profits.

*Leasing Models***:** Another financing option under consideration is a leasing model where franchisees lease the solar infrastructure and equipment from another company. This would reduce the upfront costs for entrepreneurs and allow them to pay for the infrastructure over time, as their business generates revenue.

Market Expansion

With demonstrated demand from the tourism sector, the project plans to expand marketing efforts to fully capitalize on this opportunity. Partnerships with safari lodges, hotels, and tourism agencies are being explored, with the aim of creating long-term supply agreements. These partnerships would not only increase the visibility of locally grown mushrooms but also provide a stable customer base for franchisees. Associating the brand with eco-friendly and locally sourced produce would enhance the reputation of both the farm and its partners, co-benefiting both sides in terms of marketing and brand positioning.

Training Programs

As part of the franchising system, training programs will be integral to ensuring that each new farm operates effectively and efficiently. These programs will include comprehensive instruction on mushroom cultivation techniques, solar energy management, and post-harvest handling. Training will be offered both in-person and via digital platforms to ensure accessibility for farmers in remote regions. Regular workshops and follow-up support will help franchisees maintain quality

standards and troubleshoot operational challenges, ensuring the long-term success of the replicated farms.

Despite the progress made, several hurdles remain in the path of successful multiplication. Securing the necessary capital for infrastructure, as outlined above, will be one of the biggest challenges. Ensuring a consistent and reliable supply of spawn will also be critical, as the success of each farm hinges on access to high-quality inputs. Additionally, ongoing technical support, particularly for the solar battery systems and cooling technologies, will be essential to ensure that the farms operate smoothly and sustainably. Addressing these challenges will be key to scaling the project successfully and achieving its full potential across the region.

6.2 Impact / Sustainability

In the medium term, the sustainable effects of the project are expected to be significant, both in terms of environmental protection and socio-economic development.

Environmental Impact: The project's reliance on solar power ensures a continued reduction in greenhouse gas emissions and reliance on fossil fuels. As the model is replicated, it has the potential to further increase the renewable energy capacity in rural areas, contributing to the overall reduction of carbon emissions.

Socio-Economic Impact: The economic benefits of mushroom farming, combined with the farm's low water usage and resilience to climate fluctuations, make it a viable option for farmers across Tanzania. By providing an additional income source and promoting the use of local agricultural waste, the project contributes to improved food security and income diversification, particularly in rural communities.

Scalability: The simplicity of the farm's design, combined with the success of its solar-powered energy system, ensures that the project can be easily scaled and adapted to other regions. This scalability, coupled with market demand, positions the project as a sustainable model for future agricultural development across Tanzania and beyond.

7. Lessons Learned / Conclusions

The Solar Mushroom Farm project has yielded valuable insights into the challenges and opportunities associated with solar-powered agricultural production in Tanzania. Through the process of designing, constructing, and operating the farm, several key lessons have emerged that can inform future projects of a similar nature. These findings have implications not only for scaling the project within Tanzania but also for replicating the model across other regions facing similar energy and agricultural challenges.

Main Findings and Conclusions

- *Farm Setup and Operations*: The containerized farm model is an effective solution for controlled production, allowing scalable mushroom cultivation. However, operational costs—particularly for raw materials, labor, packaging, and distribution—were higher than initially expected.
- *Energy Efficiency and Resource Management*: Solar energy provided a reliable power source, but optimizing energy use was a significant challenge. The initial solar direct cooling system, while innovative, proved insufficient for cooling the growth and inoculation rooms. The switch to a conventional split-phase cooling system improved energy efficiency and system reliability. However, cooling remains energy-intensive, leading us to adjust our approach. Focusing on humidity control instead of precise temperature regulation significantly reduced energy consumption while still supporting healthy mushroom growth. This shift not only improved energy efficiency but also simplified the farm's environmental management.
- *Market and Sales Development*: Establishing a stable supply chain and maintaining consistent product quality were crucial to building customer confidence, particularly in the high-demand tourism sector. The launch of the "Fungitamu" brand for fresh and dried mushrooms increased visibility and market penetration. Future projects should prioritize building strong relationships with buyers and ensuring reliable product delivery to meet market expectations, especially in sectors like hospitality and tourism.
- *Labor and Training*: Developing local capacity through the hiring and training of staff was vital to the project's success. The farm currently employs two full-time workers who received comprehensive training. Investing in local talent not only supports the operational sustainability of the farm but also contributes to local economic development. Future replications should similarly emphasize staff training to ensure long-term success.
- *Adaptability and Flexibility*: Flexibility in adapting to challenges was key to optimizing the farm's productivity and energy balance.

Recommendations for Similar Projects

- *Simplify Operations*: Focus on controlling humidity rather than temperature to reduce energy demands. Consider integrating outdoor growing where feasible to further lower costs and broaden production options.
- *Budget for the Unexpected*: Account for unforeseen costs, particularly in operations, labor, and logistics. Build financial flexibility into the budget to accommodate fluctuating local costs.
- *Prioritize Customer Trust*: Reliability in supply and quality is vital. Developing strong, long-term relationships with customers, especially in the hospitality industry, will help establish confidence in local products.
- *Leverage Local Resources*: Use locally available materials and agricultural waste to reduce costs and enhance sustainability, ensuring that the project remains resilient to external factors.