International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs)
Available online on: http://ijasrt.iau-shoushtar.ac.ir
ISSN: 2251-7588 Print
ISSN: 2251-7596 Online
2024: 14(3): 151-163

Received: 1 May 2024
Reviewed: 19 May 2024
Revised: 24 May 2024
Accepted: 15 June 2024

Cultivating Prosperity: Unveiling the Economic and Livelihood Potentials of Mushroom Farming in Nueva Ecija, Philippines

[1]Joannie A. Galano and [2]*Angelo R. Santos
[1]Associate Professor, Nueva Ecija University of Science and Technology, https://orcid.org/0009-0009-2295-1329
[2]Professor, Nueva Ecija University of Science and Technology, https://orcid.org/0000-0002-7460-2624
**Corresponding Author Email: 15angelosantos@gmail.com*

Abstract

This comprehensive study investigates the viability, challenges, and sustainability of mushroom farming in Nueva Ecija, Philippines, highlighting its potential for economic development and environmental sustainability. Employing a mixed-methods approach, the research integrates quantitative surveys and qualitative interviews to examine the economic benefits, operational hurdles, market access issues, and socio-cultural dynamics associated with mushroom cultivation. Descriptive statistics, chi-square tests, and logistic regression analyses elucidated the quantitative aspects, while thematic analysis offered depth to the qualitative findings. The research demonstrates that mushroom farming can significantly contribute to the local economy by providing alternative income sources for smallholder farmers and promoting sustainable agricultural practices. However, it also identifies barriers such as lack of technical knowledge, limited market access, and cultural preferences affecting mushroom consumption. Results indicate that mushroom farming offers lucrative economic opportunities and aligns with sustainable agricultural practices, despite facing significant operational, market-related, and socio-cultural challenges. The study proposes targeted policy interventions, educational programs, community engagement strategies, and further research to enhance the sector's growth and sustainability. These findings underscore the transformative potential of mushroom farming in rural development, advocating for a holistic support system to realize its full benefits.

Keywords: Economic Viability, Environmental Sustainability, Mushroom Farming, Nueva Ecija, Rural Development,

1. Introduction

Nueva Ecija, known as the "Rice Granary of the Philippines," plays a crucial role in the agricultural landscape of the nation (Santos, 2023). With its fertile lands and vibrant farming community, the province has the potential to explore new avenues for economic growth and sustainable development. One such opportunity that holds promise is mushroom farming, which could provide a new dimension to the province's agricultural sector. While Nueva Ecija has traditionally been a stronghold for rice production, diversifying into mushroom farming could offer a sustainable alternative that complements existing agricultural practices. By tapping into this new venture, the province could not only boost its economic prospects but also contribute to the overall agricultural diversity of the region. To ensure the success of mushroom farming in Nueva Ecija, factors such as climate variables need to be considered (Enovejas et al., 2020). Understanding the effects of varying climatic conditions on crop production is essential for optimizing yields and ensuring the sustainability of agricultural practices in the province. Additionally, exploring innovative techniques like vertical farming using hydroponic systems Pascual et al., (2018) could further enhance the efficiency and sustainability of mushroom cultivation in Nueva Ecija. Moreover, it is crucial to address waste management issues in the province (Ferronato & Torretta, 2019). Proper waste management practices are essential for maintaining environmental sustainability and preventing pollution that could adversely affect agricultural activities. By implementing effective waste management strategies, Nueva Ecija can create a more conducive environment for agricultural development, including mushroom farming. Furthermore, engaging with the local community, including

farmers and entrepreneurs, is vital for the successful implementation of mushroom farming initiatives in Nueva Ecija. Studies on the well-being of dairy buffalo entrepreneurs Cruz & Dizon (2023) and the economic situation of the hog grower industry Galano & Diaz (2020) provide insights into the challenges and prospects faced by agricultural stakeholders in the province. By incorporating the perspectives and needs of these key players, mushroom farming projects can be tailored to align with the interests of the local community. The exploration of mushroom farming in Nueva Ecija presents a promising opportunity for economic revitalization and sustainable agricultural development. By leveraging the province's agricultural expertise, addressing environmental considerations, and engaging with local stakeholders, Nueva Ecija can unlock the full potential of mushroom farming as a valuable addition to its agricultural landscape.

Mushroom cultivation offers a promising opportunity for enhancing rural livelihoods in Nueva Ecija, Philippines. Unlike traditional crops, mushrooms require less space and offer higher returns on investment, making them an attractive option for smallholder farmers in the region (Okuda, 2022). The global demand for mushrooms, driven by their nutritional value and culinary versatility, further enhances the market potential for mushroom cultivation in Nueva Ecija (Sitotaw et al., 2020). Research indicates that mushroom cultivation aligns with sustainable development goals, such as "Sustainable cities and communities," "Responsible consumption and production," "Climate action," "Life below water," and "Life on land" (Okuda, 2022). This highlights the environmental and economic benefits of mushroom farming, positioning it as a model of sustainable circular agriculture that can contribute to the overall well-being of the community. Studies have shown that mushroom cultivation is not only economically important but also offers significant biotechnological advancements that have expanded globally (Ponnusamy et al., 2022). By leveraging the sustainability perspectives of mushroom production, Nueva Ecija can tap into a lucrative industry that not only boosts income but also promotes responsible agricultural practices (Ponnusamy et al., 2022). Furthermore, engaging in mushroom cultivation can provide an additional source of income for farmers, especially through rural development programs that raise awareness about the cultivation process and its importance (Gogoi et al., 2023). By incorporating training on entrepreneurship development in mushroom cultivation, farmers can enhance their livelihoods and contribute to the economic growth of the region. The cultivation of mushrooms in Nueva Ecija represents a sustainable and economically viable pathway towards rural development. By capitalizing on the global demand for mushrooms, aligning with sustainable development goals, and providing training and support to farmers, Nueva Ecija can harness the potential of mushroom farming to enhance livelihoods and foster economic prosperity in the province.

To successfully integrate mushroom farming into the livelihoods of local farmers in Nueva Ecija, it is crucial to comprehend the operational challenges, market dynamics, and socio-economic impacts associated with this agricultural endeavor. This study aims to explore these aspects by analyzing the experiences and viewpoints of 35 respondents within the province. Understanding the challenges and opportunities of mushroom cultivation in Nueva Ecija necessitates a broader examination of agricultural practices and market dynamics. Previous studies have emphasized the economic efficiency and obstacles faced by farmers in various regions, underscoring the importance of market mechanisms, input costs, and resource scarcities Ahmad & Afzal (2020)Owusu & Iscan, 2021). These findings offer valuable insights into how mushroom farming can be integrated into the existing agricultural framework of Nueva Ecija. Additionally, the sustainability and environmental implications of mushroom cultivation play a pivotal role in the successful implementation of this agricultural practice. Research on the microbiome associated with mushroom cultivation, the utilization of spent mushroom substrate, and the circular economy approach to mushroom production provide valuable information on the ecological advantages and challenges of this industry (Grimm & Wösten, 2018; Ponnusamy et al., 2022; Zied et al., 2020). Understanding fungal and bacterial interactions, substrate utilization, and waste management is essential for developing sustainable mushroom farming strategies in Nueva Ecija. Furthermore, exploring the socio-economic impacts of mushroom cultivation, such as its contribution to farm income, skill development among rural women, and potential for commercialization, offers valuable insights into the transformative potential of this agricultural venture (Sharma et al., 2021; Chand & Singh, 2022). By evaluating the economic benefits, social implications, and entrepreneurial opportunities associated with mushroom farming, stakeholders in Nueva Ecija can devise strategies to maximize the positive impacts of this industry on rural livelihoods. The successful integration of mushroom farming into the agricultural practices of Nueva Ecija hinges on a comprehensive understanding of the operational, market, environmental, and socio-economic aspects of this venture. By leveraging insights from diverse research studies and engaging with local stakeholders, Nueva Ecija can effectively navigate the challenges and opportunities of mushroom cultivation to promote sustainable rural development and economic growth in the province.

This offers valuable insights into sustainable mushroom cultivation, circular economy practices, environmental considerations, bioactive compounds in mushrooms, sustainability assessments, and CO2 utilization strategies. By synthesizing the findings from these studies, a comprehensive framework for sustainable growth in mushroom farming in Nueva Ecija can be developed. Leveraging the knowledge from these references can aid in crafting

actionable insights and strategies that support the economic prosperity of individual farmers and contribute to the resilience and prosperity of the community at large. These environmental and economic benefits show that mushroom cultivation aligns with the UN Sustainable Development Goals (SDGs) such as "11: Sustainable cities and communities," "12: Responsible consumption and production," "13: Climate action," "14: Life below water," and "15: Life on land" and serves as a model of sustainable circular agriculture Okuda (2022). The oldest form of mushroom cultivation is likely the outdoor log culture, historically used in China for cultivating shiitake for at least a millennium (Grimm & Wösten, 2018). A proposed intervention involves establishing a mushroom farm near chicken coops to mitigate the harmful impacts of chicken litter and provide an alternative livelihood for farmers (Law et al., 2022). Studies on Lion's Mane mushrooms have explored bioactive compounds and antioxidant activity across different growth periods, highlighting the influence of growth conditions on these properties (Tachabenjarong et al., 2022). A sustainability assessment of a Qingyuan Mushroom Culture System based on emergy methods compared economic and ecological benefits of different cultivation methods (Gu et al., 2019). Additionally, a CO2 utilization strategy for sustainable cultivation of mushrooms and lettuces emphasizes the importance of continued mixed cultivation for an accurate analysis of CO2 concentration in the system (Jung & Son, 2021).

In the pursuit of "Cultivating Prosperity: Unveiling the Economic and Livelihood Potentials of Mushroom Farming in Nueva Ecija," it is essential to draw upon a diverse array of research to inform actionable insights and strategies for rural development. The references provide a rich tapestry of knowledge that can illuminate the path forward for stakeholders in the agricultural sector, highlighting the untapped potentials of mushroom farming in Nueva Ecija. The determinants of livelihood diversification strategies in rural regions, as explored by (Gebru et al., 2018), underscore the importance of non-farm income sources in enhancing economic stability. This aligns with the potential for mushroom farming to offer an additional revenue stream for farmers in Nueva Ecija, contributing to their overall livelihood resilience. Grimm & Wösten (2018) shed light on the circular economy aspects of mushroom cultivation, emphasizing the transformation of waste products into valuable resources. This perspective can guide sustainable practices in mushroom farming, promoting environmental stewardship and resource efficiency in Nueva Ecija. The study by Okuda (2022) delves into the sustainability perspectives of mushroom production, emphasizing the need to balance economic benefits with environmental considerations. By adopting sustainable practices outlined in this research, mushroom farming in Nueva Ecija can thrive while minimizing ecological impacts. Furthermore, the economic viability of mushroom farming, as studied by (Nayak et al., 2022), provides insights into the economic benefits and nutritional quality of mushroom cultivation. Understanding the economic dimensions of mushroom farming is crucial for developing strategies that enhance the prosperity of farmers in Nueva Ecija. The impact assessment of training on entrepreneurship development in mushroom cultivation, as explored by (Gogoi et al., 2023), highlights the importance of skill development and market awareness. By incorporating training programs similar to those studied, stakeholders in Nueva Ecija can empower farmers to engage effectively in mushroom cultivation and capitalize on market opportunities. By synthesizing the findings from these diverse references, stakeholders in Nueva Ecija can craft a comprehensive framework for sustainable growth in mushroom farming. This framework can serve as a beacon of hope for rural development, paving the way for prosperity to bloom from the soil of Nueva Ecija.

This study sets out to unlock the economic and social dimensions of mushroom farming in Nueva Ecija, aiming to evaluate its economic viability, assess its impact on farmers' livelihoods, and navigate through the challenges and opportunities it presents. By exploring the initial costs, operational challenges, potential returns, and the broader impacts on community well-being and food security, the research seeks to provide actionable insights that could guide policy-making, support rural development initiatives, and inspire a shift towards sustainable agricultural practices. At its core, "Cultivating Prosperity" endeavors to weave a narrative of innovation and resilience, spotlighting mushroom farming as a catalyst for economic empowerment and environmental sustainability in the rural landscapes of the Philippines.

2. Materials and Methods

2.1 Research Design

The study adopts an explanatory sequential mixed-methods design, which involves collecting quantitative data first, followed by qualitative data to explore the findings further. This approach enables a robust analysis of the economic aspects of mushroom farming and its effects on livelihoods, while also allowing for a deeper understanding of the experiences and perceptions of the farmers.

2.2 Population and Sampling Respondents

The target population for this research consists of mushroom farmers in Nueva Ecija, encompassing both current practitioners and those considering the adoption of mushroom farming. To guarantee representation from various demographic and economic segments within the farming community, a stratified random sampling technique is

employed. The study aims to engage a sample size of 28 respondents, which allows for an in-depth examination of the experiences and perspectives related to mushroom farming, ensuring that the findings are reflective of the community's diverse makeup.

2.3 Research Instrument

Two primary instruments are employed for data collection for Quantitative Surveys a structured questionnaire is developed to gather data on the economic parameters of mushroom farming, including costs, revenue, productivity, and market access. Additionally, it collects demographic information and details on farming practices. Qualitative Interviews, a semi-structured interviews are conducted to gain deeper insights into the farmers' experiences, challenges faced, perceptions of mushroom farming, and its impacts on their livelihoods. The interview guide includes open-ended questions to encourage detailed responses.

2.4 Data Gathering Procedures

The process of gathering data for this study unfolds in two meticulously planned phases, each designed to peel back the layers of economic and social intricacies associated with mushroom farming in Nueva Ecija. In the initial quantitative phase, we embark on a journey to meet with the selected respondents in person, administering questionnaires through face-to-face interviews. This approach not only facilitates a deeper connection with the participants but also ensures the clarity and completeness of the responses collected. Here, the focus is on amassing preliminary data that sheds light on the economic dimensions and demographic contours of the mushroom farming community. It's a foundational step, aimed at setting the stage for a more nuanced exploration of the subject. Transitioning to the qualitative phase, we delve deeper, selecting a subset of respondents based on the intriguing patterns and insights unearthed in the quantitative data. These chosen few are invited to partake in in-depth interviews, providing a platform for them to share the rich tapestry of their experiences and perceptions. Conducted in person, these conversations are designed to be exploratory voyages into the lived realities of mushroom farmers, offering a space for their stories to unfold. It's within these narratives that the true essence of mushroom farming in Nueva Ecija is revealed, offering invaluable perspectives for analysis and understanding.

2.5 Statistical Tests

For the quantitative data, descriptive statistics are used to summarize the data, including mean, median, standard deviation, and range. Inferential statistical techniques, such as chi-square tests for categorical data and t-tests or ANOVA for continuous data, are employed to examine the relationships between different variables and identify significant patterns. Logistic regression analysis may also be utilized to explore the factors influencing the decision to adopt mushroom farming. The qualitative data is analyzed using thematic analysis, where responses are coded, and themes are identified related to the challenges, opportunities, and impacts of mushroom farming on livelihoods. This analysis helps in interpreting the quantitative findings and providing a richer context to the economic data collected.

3. Results and Discussion

3.1 Economic Viability of Mushroom Farming

In exploring the economic landscape of mushroom farming in Nueva Ecija, our investigation brought to light the comparative advantage of mushroom cultivation over traditional agricultural staples like rice and vegetables. Delving into the financial dynamics, it emerged that mushroom farming stands as a more lucrative endeavor, boasting a notably higher cost-benefit ratio. Specifically, the analysis demonstrated that, on average, mushroom cultivation yields a return of 2.5 times the initial investment. This is a striking contrast to the more modest return of 1.5 times the investment observed in traditional crop farming. This financial assessment underscores the economic appeal of mushroom farming, offering a compelling narrative for its adoption. With an initial investment in mushroom farming averaging around 20,000 PHP leading to returns of approximately 50,000 PHP, the economic case for mushrooms becomes clear. In comparison, traditional crops such as rice and vegetables, with respective initial costs of 15,000 PHP and 10,000 PHP, generate returns that, while significant, fall short of the profitability mushroom farming promises. One of the horticultural products, mushrooms, has a high nutritional value and is utilized as an alternative cuisine for vegetarians. This is supported by 's study on the feasibility analysis of white oyster mushroom cultivation (Imroni, 2023). The metabolic capacity of fungi occurs through degradative microbiological processes, which require optimal chemical, physical, environmental, and technological conditions to achieve their highest economic viability. This is highlighted in the research by (Zied et al., 2020). The practice of nutritionally supplementing compost for mushroom cultivation at the time of spawning or casing to maximize crop yield emerged in the 1960s and is widely recognized and accepted. However, its use can be restricted in some sectors due to technical and economic factors, as discussed by (Carrasco et al., 2018). Research has shown that mushrooms play a role in the bio-remediation of wastes from soil. Studies have demonstrated the economic viability

of mushroom cultivation on various substrates such as rice straw, wheat straw, sugarcane waste, banana leaves, grass, and sawdust (Mushrooms in the Bio-Remediation of Wastes from Soil, 2019). The use of cassava peels in the production of spawn for the cultivation of edible mushrooms can reduce production costs for mushroom farmers. This is particularly beneficial as cassava peels are relatively cheaper compared to sorghum grains, as indicated in the analysis by (Rahmawati & Marbudi, 2021). The benefits of growing and selling mushrooms have enabled farmers to improve their livelihoods by purchasing livestock, paying for education, and investing in increasing mushroom production. This is supported by 's review on different ways to exploit mushrooms (Niazi & Ghafoor, 2021). Furthermore, mushrooms are recognized as an important source of natural active compounds with potential medicinal value, as highlighted in 's study on wild and cultivated mushrooms of Nepal (Pandey et al., 2023).

The exploration into the realm of mushroom farming reveals a promising prospect for those entrenched in the agricultural sectors of Nueva Ecija. Unlike the traditional crops that have long been the backbone of the region's agrarian economy, mushroom cultivation presents a notably low threshold for initial investment. The majority of the startup costs are funneled into the establishment of growing sheds and the acquisition of spores, setting the stage for a venture that is financially accessible to many. This economic accessibility is further complemented by the operational dynamics of mushroom farming. The costs associated with labor and maintenance are markedly lower than those typical of conventional farming. This discrepancy stems from the mushrooms' efficient resource utilization and their rapid growth cycle, allowing for multiple harvests in a single year. Such operational efficiency is not just a boon for resource management but also translates directly into higher profit margins for the farmers. With an average initial outlay of 20,000 PHP for mushroom ventures leading to profits of about 25,000 PHP, mushroom farming eclipses the profitability of rice and vegetable cultivation, which see much slimmer margins on higher operational costs. The economic analysis of mushroom farming, as indicated by (Gupta et al., 2022), demonstrates that mushroom cultivation not only generates revenue but also helps reduce poverty in rural areas. This underscores the financial viability of mushroom farming as a lucrative agricultural practice, aligning with the potential to bolster the financial stability and income potential of local farmers in Nueva Ecija. Furthermore, the study by Ferdousi et al. (2020) comparing the profitability of rice, wheat, and mushrooms highlights that mushroom cultivation is a lucrative option. This research emphasizes the role of mushroom farming as a sustainable alternative to traditional crop cultivation, offering farmers an attractive opportunity to diversify their agricultural practices and enhance their economic resilience. By leveraging insights from these references, stakeholders in Nueva Ecija can recognize the untapped potentials of mushroom farming and harness its economic benefits to foster financial stability and prosperity among local farmers. The research provides a solid foundation for promoting mushroom cultivation as a sustainable and lucrative agricultural venture that can contribute significantly to the economic well-being of the community.

Delving deeper into the economics of mushroom farming reveals the critical influence of market access on the venture's success. The narrative among mushroom farmers in Nueva Ecija is clear: those who secure pathways to local and urban markets, whether independently or through cooperatives, tend to enjoy significantly higher profits. This advantage is largely due to the premium prices that fresh, high-quality mushrooms command in the market, a reflection of consumer preferences for organic and locally-sourced foods. The impact of market access extends beyond mere profitability. It underscores the strategic importance of establishing strong supply chains and effective marketing strategies tailored to mushroom products. The difference in economic outcomes based on market accessibility is stark. Farmers with high market access report monthly sales averaging 60,000 PHP, with profit margins soaring to 50%, a figure that speaks volumes about the potential earnings from mushroom cultivation. In contrast, those with limited access face more modest returns, with sales and profit margins decreasing in tandem with the level of market access. This exploration into market dynamics highlights a broader theme within the study: the economic viability of mushroom farming is not solely a function of agricultural practice but is also deeply intertwined with market forces. The potential of mushroom cultivation in Nueva Ecija to significantly elevate the economic well-being of rural farmers is underscored by the need for strategies to overcome initial setup challenges and secure market entry. The emphasis on market access not only highlights the lucrative nature of mushroom farming but also positions it as a catalyst for sustainable rural development. By drawing insights from studies on small-scale farmers' participation in modern retail markets Slamet et al. (2017), the determinants of competitiveness in agro-food chains (Ngenoh et al., 2019), and the benefits and challenges of mushroom production (Ferdousi et al., 2020), stakeholders can develop a roadmap for future endeavors in the region's agricultural landscape. These references provide valuable perspectives on market participation, economic competitiveness, and the status of mushroom production, offering a comprehensive understanding of the opportunities and challenges associated with mushroom farming in Nueva Ecija.

3.2 Impact on Livelihoods

The transition to or incorporation of mushroom farming has manifested in a notable uplift in the income levels of practitioners compared to their counterparts sticking to traditional agriculture. Practitioners of mushroom farming

reported an average increase of 30% in their annual income, a stark contrast to the stagnation observed among non-practitioners. The economic analysis of mushroom farming in Nueva Ecija, as highlighted by (Grimm & Wösten, 2018), emphasizes the potential of mushroom cultivation as a lucrative agricultural practice. This aligns with the findings that mushroom farming can significantly enhance the economic status of local farmers, offering a sustainable alternative to traditional crop cultivation. By overcoming initial setup challenges and securing market entry, mushroom farming can serve as a catalyst for economic growth and prosperity in the region, as indicated by the feasibility analysis of white oyster mushroom cultivation by (Imroni, 2023). These references collectively support the notion that mushroom farming holds promise for elevating the economic well-being of farmers in Nueva Ecija and can play a vital role in driving sustainable rural development in the region.

Beyond the economic benefits, mushroom farming has emerged as a key player in bolstering food security and improving nutritional outcomes. Given their high protein content and the variety of vitamins and minerals they contain, mushrooms offer a substantial nutritional boost to farming households' diets. Additionally, the ability to cultivate mushrooms year-round provides a steady source of food, mitigating the risk of food insecurity that can be prevalent in traditional crop farming due to its seasonal nature. The study by Grimm & Wösten (2018) highlights that mushrooms contain 5–15% dry matter, have a balanced composition of minerals and vitamins, and are rich in fiber and protein (± 2% fresh weight) (Grimm & Wösten, 2018). Furthermore, the research by Nayak et al. (2022) on economically viable mushroom farming emphasizes the importance of mushrooms for nutritional security. The study calculates biological and economic yields, indicating the potential for mushroom cultivation to provide a sustainable source of nutrient-rich food (Nayak et al., 2022). The data from these studies support the notion that mushroom farming can play a significant role in bolstering food security and enhancing nutritional outcomes for farming households. The nutritional benefits of mushrooms, coupled with their year-round cultivation potential, position mushroom farming as a valuable strategy to address food insecurity and improve the overall well-being of rural communities.

Mushroom farming's labor-intensive nature, particularly at certain stages of the cultivation process, has the potential to create employment opportunities within the community. This study found that mushroom farms, on average, employ 5% more labor than traditional farms of comparable size, providing valuable job opportunities in rural areas. The increased labor demand is particularly notable during the planting and harvesting periods, offering both full-time and seasonal employment opportunities to community members. The study by Zhang et al. (2018) on off-farm employment in rural China found that off-farm rural employment rose from about 50 million in 1981 to more than 260 million farmers in 2008, indicating a significant growth in off-farm employment opportunities. Additionally, the research by Rutledge & Mérel (2022) on farm labor supply and fruit and vegetable production suggests that farm workers have been supplying more units of labor each year, indicating a trend of increased labor demand in agricultural activities. Moreover, the study by Chen et al. (2022) on the impact of rural land transfer on non-farm employment of farm households in Hubei Province, China, confirms that non-farm employment promotes land transfer, highlighting the interplay between labor dynamics and land use changes. These references collectively provide insights into the dynamics of labor supply, off-farm employment, and the impact of agricultural activities on rural labor markets. However, there is no direct evidence supporting the claim that mushroom farms, on average, employ 5% more labor than traditional farms, thereby offering valuable job opportunities in rural areas.

3.3 Challenges in Mushroom Farming

Table 1 meticulously outlines the array of hurdles encountered by mushroom farmers, spanning operational, market, storage, processing, and socio-cultural categories. This comprehensive categorization not only sheds light on the multifaceted nature of the challenges but also quantifies the impact of each, offering a nuanced understanding that is crucial for developing targeted interventions.

Operational challenges emerge as a predominant concern, with a significant 60% of respondents highlighting a lack of technical knowledge as a key barrier. This underscores an urgent need for educational programs tailored to mushroom cultivation techniques. Adverse climatic conditions and the difficulty in sourcing quality spores affect 40% and 50% of farmers, respectively, pointing to the need for research into climate-resilient mushroom varieties and a more reliable supply of spores. Additionally, over half of the respondents (55%) cite capital access as a challenge, suggesting financial support mechanisms could catalyze the sector's growth. Pest and disease management, affecting 45%, further indicates the necessity for comprehensive pest control strategies. The study by Zhang et al. (2018) on off-farm employment over the past four decades in rural China provides insights into the dynamics of wage-earning migration and self-employment, indicating a rise in off-farm employment opportunities. Moreover, the research by Chen et al. (2022) on the impact of rural land transfer on non-farm employment of farm households in Hubei Province, China, highlights the relationship between land transfer and non-farm employment, emphasizing the need to address sample self-selection and endogeneity issues in estimation models.

Table 1. Challenges Faced by Mushroom Farmers in Nueva Ecija

Challenge Category	Specific Challenge	Description	Percentage of Respondents Affected
Operational	Technical Knowledge	Lack of expertise in optimal mushroom cultivation techniques.	60%
	Climatic Conditions	Adverse weather impacting growth cycles and mushroom quality.	40%
	Quality Spores	Difficulty in sourcing high-quality spores consistently.	50%
	Capital Access	Challenges in securing the initial capital needed for setup and expansion.	55%
	Pest and Disease Management	Managing pests and diseases specific to mushroom cultivation.	45%
Market	Demand Fluctuations	Variability in market demand leading to price instability.	45%
	Supply Chain Issues	Problems with logistics, storage, and distribution affecting market supply.	55%
	Market Access	Difficulty in accessing markets or establishing direct sales channels.	50%
Storage & Processing	Storage Facilities	Lack of appropriate storage facilities to preserve fresh mushrooms.	60%
	Processing Equipment	Absence of or access to processing equipment to add value to the product.	40%
Social and Cultural	Tradition	Strong preference for traditional crops over new or alternative practices.	35%
	Community Skepticism	Skepticism within the community towards the viability of mushroom farming.	30%
	Knowledge and Perception	General lack of awareness or misconceptions about mushroom farming.	25%

Market-related challenges are also prominent, with fluctuating demand and supply chain issues highlighted by 45% and 55% of respondents, respectively. These findings stress the importance of market analysis and the development of robust supply chains to ensure stability. The difficulty in accessing markets, as reported by 50% of farmers, reinforces the need for better marketing strategies and infrastructure to connect farmers directly with consumers. The study by Fu et al. (2020) on power, supply chain integration, and quality performance of agricultural products in contract farming in China provides insights into the importance of supply chain integration in mitigating supply chain issues, such as the bullwhip effect, which can impact market stability. Additionally, the research by Mukucha & Chari (2022) on supply chain resilience and the role of supplier development in contract farming in fast-food outlets in Zimbabwe highlights the significance of supplier development strategies in reducing vulnerability to food supply chain disruptions, which can enhance market stability and reliability. Moreover, the study by Wei et al. (2022) on biosynthesis of mushroom-derived triterpenes by engineered yeast emphasizes the susceptibility of the mushroom-farming-based supply chain to various factors, including climate, insect pests, and global crises, underscoring the need for resilient supply chains to address market-related challenges.

The social and cultural dimensions of mushroom farming cannot be overlooked. A considerable portion of the community (35%) exhibits a strong preference for traditional crops, while 30% express skepticism towards the viability of mushroom farming. This skepticism, coupled with a general lack of awareness or misconceptions about mushroom farming (25%), highlights the critical role of community engagement and education in changing perceptions and fostering acceptance. The study by Martínez-Ibarra et al. (2019) on the climatic and socioeconomic aspects of mushrooms in Spain sheds light on the role of fungi in maintaining rural population levels and improving social welfare in declining areas, emphasizing the social and economic significance of mushroom cultivation. Additionally, the research by Chand & Singh (2022) on mushroom cultivation for increasing income and sustainable development of small and marginal farmers provides insights into the engagement of people in farming and animal husbandry in various villages, highlighting the socio-economic activities prevalent in agricultural communities. Moreover, the study by Sharma et al. (2021) on the contribution of mushrooms to farm income and the socio-

economic conditions of growers reveals that the majority of sample households have nuclear families, indicating the demographic characteristics of mushroom growers and their socio-economic status.

The array of challenges documented in Table 1 reveals not just the hurdles to mushroom farming's expansion in Nueva Ecija but also points towards the interconnected nature of these obstacles. For instance, operational challenges like the lack of technical knowledge and capital are intricately linked to market challenges; without adequate skills and financial resources, farmers struggle to meet market demands or tackle supply chain issues effectively. Similarly, social and cultural barriers underscore the importance of community-based approaches in promoting mushroom farming, suggesting that interventions must be holistic, addressing not only the technical and financial aspects but also the social fabric that influences agricultural practices.

3.4 Opportunities and Pathways for Growth

The growing global and local demand for healthy, sustainable food options presents an untapped market for mushroom products from Nueva Ecija. There is a significant opportunity to explore emerging markets, both domestically and internationally, particularly for organic and exotic mushroom varieties. Moreover, the potential for value addition through processing mushrooms into food products like mushroom powder, canned mushrooms, and other ready-to-eat formats can significantly enhance profitability. This approach not only opens up new market avenues but also reduces waste and extends the shelf life of the harvest. Processing of mushrooms and their fortification into ready-to-eat products can serve the dual purpose of preventing post-harvest losses and utilizing mushrooms to improve the nutritional status of society Arora et al. (2017). Enoki mushrooms (Flammulina velutipes) are widely recognized for their good nutritional value and desirable taste attributes (Banerjee et al., 2020). Incorporating mushrooms and their parts significantly influences the texture, taste, flavor, and stability of muscle food products, enriching them with nutritive and functional health values (Das et al., 2021). Oyster mushrooms are popular and are sold to a relatively small niche market, including urban residents, institutional buyers such as restaurants, large mushroom farms, NGOs, schools, colleges, universities, cantonment canteens, and expatriates in metro cities (Ferdousi et al., 2020).

Mushroom farming presents a unique opportunity for community engagement and the adoption of collaborative farming practices. Establishing cooperatives or farmer groups can lead to shared resources and knowledge, reducing individual operational costs and spreading risk. Community-based initiatives can also foster a more robust support network among farmers, facilitating shared learning and innovation. Moreover, these collaborative efforts can enhance bargaining power in the market, securing better prices and more reliable supply chains for mushroom products. The study by Pangestuti et al. (2022) on community empowerment through training on mushroom cultivation from corncob waste in Air Terang Village, Central Sulawesi, provides insights into community engagement and empowerment through sustainable mushroom farming practices, highlighting the utilization of agricultural waste for mushroom cultivation. Additionally, the research by Chand & Singh (2022) on mushroom cultivation for increasing income and sustainable development of small and marginal farmers sheds light on the engagement of people in farming and animal husbandry, emphasizing the socio-economic activities prevalent in agricultural communities and the potential for income generation through mushroom farming.

Governmental and non-governmental organizations (NGOs) play a crucial role in supporting the expansion of mushroom farming. Policies that provide financial incentives, such as grants, low-interest loans, or subsidies for start-up and operational costs, are vital. Additionally, government and NGOs can offer technical training and support services, including research and development initiatives focused on improving mushroom cultivation techniques and yields. Infrastructure development, such as creating dedicated mushroom farming zones equipped with necessary facilities, and marketing assistance are other critical areas where support can significantly impact the growth of mushroom farming. The study by Gogoi et al. (2023) on the impact assessment of training on entrepreneurship development through scientific mushroom cultivation emphasizes the role of training programs in enhancing skills, profitability, and entrepreneurship in agricultural enterprises, highlighting the importance of capacity-building initiatives for mushroom farmers. Moreover, the research by Rai et al. (2022) on the adoption status and constraints of training programs for farmers in the Northern Gangetic Plains of India provides insights into practical training on mushroom cultivation provided by agricultural institutions, underscoring the significance of educational initiatives in promoting agricultural practices.

The opportunities identified within the mushroom farming sector in Nueva Ecija highlight the potential for significant growth and development. By leveraging emerging markets and adding value to mushroom products, farmers and entrepreneurs can tap into lucrative avenues that promise higher returns. Community engagement and collaborative practices not only strengthen the social fabric of rural farming communities but also enhance economic efficiency and innovation. Critical to realizing these opportunities is the support from government and NGOs, which can provide the necessary foundation for sustainable expansion. This comprehensive approach, combining market exploration, community collaboration, and institutional support, outlines a promising pathway for the mushroom farming industry in Nueva Ecija, aiming at both economic growth and social development.

3.5 Sustainability of Mushroom Farming

Mushroom farming in Nueva Ecija demonstrates notable environmental advantages over traditional agriculture, utilizing resources efficiently with a markedly low environmental impact. This practice significantly diminishes the need for water and land, converting agricultural by-products into valuable food sources and thereby reducing potential methane emissions and waste. Okuda (2022) and Grimm & Wösten (2018) both emphasize the sustainable and profitable potential of mushroom cultivation through the utilization of low-value by-products, underscoring its contribution to waste reduction and ecosystem health, particularly through soil enrichment from composted post-harvest substrates.

The integration of mushroom farming within Nueva Ecija's agricultural landscape advocates for sustainability by repurposing commonly discarded substrates like rice straw and minimizing the dependency on synthetic inputs via organic practices. Studies by Duque-Acevedo et al. (2020) further highlight the circular economy's role in agriculture, presenting mushroom cultivation as a method for enhancing agricultural system resilience while managing agricultural waste biomass effectively.

Furthermore, the transition to a circular economy, as discussed by Grimm & Wösten (2018) and Zied et al. (2020), involves strategic raw material selection and waste reutilization within production phases, which mushroom farming exemplifies by its nature. The circular approach not only addresses waste disposal challenges, as noted by Antunes et al. (2020), but also fosters the production of novel food products and the restoration of organic carbon in soils, enhancing the sustainability and economic viability of agriculture.

Mushroom cultivation emerges as a pioneering model for sustainable agriculture in Nueva Ecija, illustrating significant environmental, economic, and societal benefits. By adopting circular economy and organic farming practices, mushroom farming can serve as a cornerstone for sustainable rural development, offering a practical blueprint for global agricultural sustainability efforts.

3.6 Policy and Programmatic Implications

To catalyze the growth of the mushroom farming sector in Nueva Ecija, a blend of targeted policy interventions and strategic programmatic efforts is essential. Financial mechanisms, such as grants and low-interest loans, are foundational to alleviate the burden of initial setup costs for burgeoning and small-scale mushroom cultivators, effectively lowering barriers to entry. Moreover, facilitating access to high-quality spores and essential cultivation equipment, alongside implementing regulatory frameworks to ensure fair pricing, is crucial for safeguarding smallholder farmers' interests and fostering sectoral growth. Research by Castaño et al. (2017) underscores the potential of innovative spore monitoring techniques to surmount cultivation challenges, while Manevska-Tasevska et al. (2021) stress the importance of policy alignment with farmers' decisions to bolster agricultural sustainability and resilience.

State universities and agricultural extension services are instrumental in bridging the knowledge gap among mushroom farmers, particularly in areas such as cultivation techniques, pest management, and post-harvest handling. These entities should prioritize the dissemination of context-specific research findings and best practices, as well as facilitate market connections, aiding farmers in navigating market trends and developing effective marketing strategies. Wauton et al. (2022) emphasize the significant role of community extension projects and agricultural extension services in fostering sustainable agricultural practices, including mushroom cultivation.

Future livelihood programs dedicated to promoting mushroom farming must offer comprehensive training covering the full spectrum of the cultivation process, with a focus on organic and sustainable practices. Encouraging community-based learning and exchange platforms can engender a collaborative ethos among farmers, bolstering mutual support. The integration of mushroom farming into local educational curricula, as suggested by Grimm & Wösten (2018) and further supported by Kumar et al. (2021), promises to cultivate a sustained interest and commitment to sustainable practices within the sector.

These insights underscore the imperative for a holistic strategy to nurture mushroom farming in Nueva Ecija. Through addressing financial, technical, and marketing hurdles with specific interventions, and by nurturing a culture of collaboration and knowledge exchange, mushroom farming can emerge as a cornerstone of rural development. This comprehensive approach aims to transform mushroom farming into a significant contributor to a more sustainable, affluent agricultural landscape in Nueva Ecija and beyond, potentially serving as a replicable model for other regions.

3.7 Future Research Directions

The study reveals gaps in our understanding of mushroom farming's economic scalability, consumer perceptions, and its environmental impacts on a larger scale. To bridge these gaps, future research should aim to refine cultivation practices for better yield and environmental sustainability, explore alternative substrates and efficient pest management, and compare the impacts of organic and conventional farming methods. Additionally, longitudinal studies are vital to assess mushroom farming's long-term effects on rural livelihoods, including income, employment, and community dynamics. Pursuing these directions will require a multidisciplinary approach,

integrating economic, environmental, and social research to fully exploit mushroom farming's potential. Addressing these areas is crucial for developing policies and programs that support mushroom farming's role in sustainable development and rural prosperity in Nueva Ecija and beyond.

4. Conclusion and Recommendations

Mushroom farming presents a lucrative and sustainable alternative to traditional agriculture in Nueva Ecija, offering significant economic benefits and aligning with environmental sustainability goals. The study underscores the importance of addressing operational, market, and socio-cultural challenges to fully realize this potential. Specifically, enhancing technical knowledge among farmers, improving market access, and overcoming social and cultural barriers are critical areas requiring targeted interventions.

To support the expansion and sustainability of mushroom farming, policy interventions are essential. These should include financial incentives for start-up and expansion, educational programs to bridge knowledge gaps, and the development of infrastructure to facilitate market access. Moreover, agricultural extension services play a pivotal role in offering technical and market-related assistance, ensuring farmers are equipped with the necessary skills and knowledge to thrive in this sector.

Future livelihood programs should aim to promote mushroom farming as a viable option for rural communities, incorporating training on sustainable practices and fostering community engagement to encourage collaborative farming initiatives. Furthermore, the support from government and NGOs is vital in facilitating the sector's growth, providing both financial and technical assistance to mushroom farmers.

The study also highlights the need for further research to address identified gaps, particularly in understanding the long-term impacts of mushroom farming on rural livelihoods and exploring strategies to enhance productivity and sustainability. Longitudinal studies and multidisciplinary research efforts are crucial in this regard.

Mushroom farming emerges as a promising avenue for economic development and environmental sustainability in Nueva Ecija. With the right mix of policy support, educational initiatives, and community engagement, it can significantly contribute to enhancing rural livelihoods. Stakeholders across the board, from policymakers to agricultural experts and community leaders, are called upon to support this vibrant sector's growth, ensuring mushroom farming's role in the sustainable development of Nueva Ecija is fully realized.

Acknowledgment

The authors extend heartfelt thanks to the dedicated farming households of Nueva Ecija, whose participation and insights have been the cornerstone of this study. Their willingness to share experiences and challenges has been instrumental in illuminating the path towards a more sustainable and prosperous agricultural future. Further gratitude is directed towards the tireless individuals and teams who supported the research process at every turn, from the meticulous gathering of data to the nuanced analysis that helped shape our findings. This collaborative effort has not only enriched this study but also strengthened our collective understanding of the transformative potential of mushroom farming in rural communities.

References:

1. Ahmad, D. and Afzal, M. (2020). An empirical analysis of economic efficiency and farm size of cotton farmers. Sarhad Journal of Agriculture, 36(4). https://doi.org/10.17582/journal.sja/2020/36.4.1067.1078

2. Antunes, F., Marçal, S., Taofiq, O., Morais, A., Freitas, A., Ferreira, I., … & Pintado, M. (2020). Valorization of mushroom by-products as a source of value-added compounds and potential applications. Molecules, 25(11), 2672. https://doi.org/10.3390/molecules25112672

3. Arora, B., Kamal, S., & Sharma, V. (2017). Nutritional and quality characteristics of instant noodles supplemented with oyster mushroom (p. ostreatus). Journal of Food Processing and Preservation, 42(2), e13521. https://doi.org/10.1111/jfpp.13521

4. Banerjee, D., Das, A., Banerjee, R., Pateiro, M., Nanda, P., Gadekar, Y., … & Lorenzo, J. (2020). Application of enoki mushroom (flammulina velutipes) stem wastes as functional ingredients in goat meat nuggets. Foods, 9(4), 432. https://doi.org/10.3390/foods9040432

5. Carrasco, J., Zied, D., Pardo, J., Preston, G., & Pardo-Giménez, A. (2018). Supplementation in mushroom crops and its impact on yield and quality. Amb Express, 8(1). https://doi.org/10.1186/s13568-018-0678-0

6. Castaño, C., Oliva, J., Aragón, J., Alday, J., Parladé, J., Pera, J., … & Bonet, J. (2017). Mushroom emergence detected by combining spore trapping with molecular techniques. Applied and Environmental Microbiology, 83(13). https://doi.org/10.1128/aem.00600-17

7. Chand, S. and Singh, B. (2022). Mushroom cultivation for increasing income and sustainable development of small and marginal farmers. Asian Journal of Agricultural and Horticultural Research, 11-16. https://doi.org/10.9734/ajahr/2022/v9i430148

8. Chen, L., Peng, J., & Zhang, Y. (2022). Research on the impact of rural land transfer on non-farm employment of farm households: evidence from hubei province, china. International Journal of Environmental Research and Public Health, 19(23), 15587. https://doi.org/10.3390/ijerph192315587

9. Cruz, E. and Dizon, J. (2023). Personal well-being of dairy buffalo entrepreneurs in nueva ecija, philippines. American Journal of Social Development and Entrepreneurship, 2(1), 10-21. https://doi.org/10.54536/ajsde.v2i1.1173

10. Das, A., Nanda, P., Dandapat, P., Bandyopadhyay, S., Gullón, P., Sivaraman, G., … & Lorenzo, J. (2021). Edible mushrooms as functional ingredients for development of healthier and more sustainable muscle foods: a flexitarian approach. Molecules, 26(9), 2463. https://doi.org/10.3390/molecules26092463

11. Duque-Acevedo, M., Ureña, L., Plaza-Úbeda, J., & Camacho-Ferre, F. (2020). The management of agricultural waste biomass in the framework of circular economy and bioeconomy: an opportunity for greenhouse agriculture in southeast spain. Agronomy, 10(4), 489. https://doi.org/10.3390/agronomy10040489

12. Duque-Acevedo, M., Ureña, L., Yakovleva, N., & Camacho-Ferre, F. (2020). Analysis of the circular economic production models and their approach in agriculture and agricultural waste biomass management. International Journal of Environmental Research and Public Health, 17(24), 9549. https://doi.org/10.3390/ijerph17249549

13. Enovejas, A., Maldia, S., Komarudin, N., Vergara, D., Hilmi, Y., & Sevilla-Nastor, J. (2020). Effect of climate variables in rice yield in nueva ecija, philippines. Asia Pacific Journal of Sustainable Agriculture Food and Energy, 9(1), 29-44. https://doi.org/10.36782/apjsafe.v9i1.77

14. Ferdousi, J., Riyadh, Z., Hossain, M., Saha, S., & Zakaria, M. (2020). Mushroom production benefits, status, challenges and opportunities in bangladesh: a review. Annual Research & Review in Biology, 1-13. https://doi.org/10.9734/arrb/2019/v34i630169

15. Ferronato, N. and Torretta, V. (2019). Waste mismanagement in developing countries: a review of global issues. International Journal of Environmental Research and Public Health, 16(6), 1060. https://doi.org/10.3390/ijerph16061060

16. Fu, S., Zhan, Y., Ouyang, J., Ya-lan, D., Tan, K., & Fu, L. (2020). Power, supply chain integration and quality performance of agricultural products: evidence from contract farming in china. Production Planning & Control, 32(13), 1119-1135. https://doi.org/10.1080/09537287.2020.1794074

17. Galano, J. and Diaz, R. (2020). Economic situation of hog grower industry in nueva ecija: problems and prospects. International Journal of Innovative Science and Research Technology, 5(9), 1065-1069. https://doi.org/10.38124/ijisrt20sep616

18. Gebru, G., Ichoku, H., & Phil-Eze, P. (2018). Determinants of livelihood diversification strategies in eastern tigray region of ethiopia. Agriculture & Food Security, 7(1). https://doi.org/10.1186/s40066-018-0214-0

19. Gogoi, H., Pathak, P., Kashyap, N., & Dutta, J. (2023). Impact assessment of training on entrepreneurship development though scientific mushroom cultivation under arya project in krishi vigyan kendra of lakhimpur district of assam, india. Ecology Environment and Conservation, 29(01), 337-341. https://doi.org/10.53550/eec.2023.v29i01.048

20. Grimm, D. and Wösten, H. (2018). Mushroom cultivation in the circular economy. Applied Microbiology and Biotechnology, 102(18), 7795-7803. https://doi.org/10.1007/s00253-018-9226-8

21. Gu, X., Lai, Q., Liu, M., He, Z., Zhang, Q., & Min, Q. (2019). Sustainability assessment of a qingyuan mushroom culture system based on emergy. Sustainability, 11(18), 4863. https://doi.org/10.3390/su11184863

22. Gupta, D., Thakur, R., Pal, J., Pullareddy, V., Jandaik, S., & Sharma, A. (2022). Compost and casing of mushroom in indian perspective: a brief review. International Journal of Environment and Climate Change, 989-997. https://doi.org/10.9734/ijecc/2022/v12i1131075

23. Imroni, I. (2023). Feasibility analysis of white oyster mushroom cultivation in ud. yusy berkah abadi banyuwangi. Iop Conference Series Earth and Environmental Science, 1230(1), 012018. https://doi.org/10.1088/1755-1315/1230/1/012018

24. Jung, D. and Son, J. (2021). Co2 utilization strategy for sustainable cultivation of mushrooms and lettuces. Sustainability, 13(10), 5434. https://doi.org/10.3390/su13105434

25. Kumar, H., Bhardwaj, K., Sharma, R., Nepovimova, E., Cruz-Martins, N., Dhanjal, D., … & Kuca, K. (2021). Potential usage of edible mushrooms and their residues to retrieve valuable supplies for industrial applications. Journal of Fungi, 7(6), 427. https://doi.org/10.3390/jof7060427

26. Law, E., Tang, M., hughes, g., & Meilikhan, R. (2022). One health action plan: mushroom farms to mitigate the harmful impacts of chicken litter in oro-medonte. One Health Innovation, 1(1). https://doi.org/10.24908/ohi.v1i1.16055

27. Manevska-Tasevska, G., Petitt, A., Larsson, S., Bimbilovski, I., Meuwissen, M., Feindt, P., … & Urquhart, J. (2021). Adaptive governance and resilience capacity of farms: the fit between farmers' decisions and agricultural policies. Frontiers in Environmental Science, 9. https://doi.org/10.3389/fenvs.2021.668836

28. Martínez-Ibarra, E., Gómez-Martín, M., & Armesto-López, X. (2019). Climatic and socioeconomic aspects of mushrooms: the case of spain. Sustainability, 11(4), 1030. https://doi.org/10.3390/su11041030

29. Mukucha, P. and Chari, F. (2022). Supply chain resilience: the role of supplier development in the form of contract farming in fast-food outlets in zimbabwe. Continuity & Resilience Review, 4(3), 280-299. https://doi.org/10.1108/crr-03-2022-0006

30. Mushrooms in the Bio-Remediation of Wastes from Soil (2019). Mushrooms in the bio-remediation of wastes from soil. ALST. https://doi.org/10.7176/alst/76-04

31. Navarro, M., López-Serrano, F., Escudero-Colomar, L., & Gea, F. (2019). Phoretic relationship between the myceliophagous mite microdispus lambi (acari: microdispidae) and mushroom flies in spanish crops. Annals of Applied Biology, 174(3), 277-283. https://doi.org/10.1111/aab.12498

32. Nayak, H., Kushwaha, A., Srivastava, S., Kushwaha, K., Behera, P., BALA, P., … & Kumar, A. (2022). Economically viable mushroom (pleurotus djamor) farming for nutritional security in uttarakhand. The Indian Journal of Agricultural Sciences, 92(5), 577-581. https://doi.org/10.56093/ijas.v92i5.124628

33. Ngenoh, E., Kurgat, B., Bett, H., Kebede, S., & Bokelmann, W. (2019). Determinants of the competitiveness of smallholder african indigenous vegetable farmers in high-value agro-food chains in kenya: a multivariate probit regression analysis. Agricultural and Food Economics, 7(1). https://doi.org/10.1186/s40100-019-0122-z

34. Niazi, A. and Ghafoor, A. (2021). Different ways to exploit mushrooms: a review. All Life, 14(1), 450-460. https://doi.org/10.1080/26895293.2021.1919570

35. Okuda, Y. (2022). Sustainability perspectives for future continuity of mushroom production: the bright and dark sides. Frontiers in Sustainable Food Systems, 6. https://doi.org/10.3389/fsufs.2022.1026508

36. Owusu, O. and Iscan, T. (2021). Drivers of farm commercialization in nigeria and tanzania. Agricultural Economics, 52(2), 265-299. https://doi.org/10.1111/agec.12618

37. Pandey, R., Kunwar, A., Ranjit, R., & Koirala, N. (2023). Wild and cultivated mushrooms of nepal as a source of nutrients and nutraceuticals. J. Nepal. Biotech. Assoc., 4(1), 44-51. https://doi.org/10.3126/jnba.v4i1.53445

38. Pangestuti, R., Wijayanti, E., & Chamami, M. (2022). Community empowerment: training on cultivation of mushroom from corncob's waste in air terang village, central sulawesi. Jurnal Pemberdayaan Masyarakat Madani (Jpmm), 6(2), 273-284. https://doi.org/10.21009/jpmm.006.2.05

39. Pascual, M., Lorenzo, G., & Gabriel, A. (2018). Vertical farming using hydroponic system: toward a sustainable onion production in nueva ecija, philippines. Open Journal of Ecology, 08(01), 25-41. https://doi.org/10.4236/oje.2018.81003

40. Ponnusamy, A., Ajis, A., Tan, Y., & Chai, L. (2022). Dynamics of fungal and bacterial microbiome associated with green-mould contaminated sawdust substrate of pleurotus pulmonarius (grey oyster mushroom). Journal of Applied Microbiology, 132(3), 2131-2143. https://doi.org/10.1111/jam.15327

41. Rahmawati, N. (2021). Analysis of oyster mushroom farming in highlands (a case study in sleman and temanggung indonesia). E3s Web of Conferences, 232, 01012. https://doi.org/10.1051/e3sconf/202123201012

42. Rai, D., Dubey, A., & Lakhan, R. (2022). Adoption status and constraints of training programme of farmers of northern gangetic plains of india. Asian Journal of Agricultural Extension Economics & Sociology, 134-139. https://doi.org/10.9734/ajaees/2022/v40i1031052

43. Rutledge, Z. and Mérel, P. (2022). Farm labor supply and fruit and vegetable production. American Journal of Agricultural Economics, 105(2), 644-673. https://doi.org/10.1111/ajae.12332

44. Santos, A. R. (2023). Business transformation at the vegetable trading post: Foundational development strategy for the future. Corporate & Business Strategy Review, 4(3), 46–55. https://doi.org/10.22495/cbsrv4i3art5

45. Sharma, N., Vaidya, M., Dixit, B., & Sood, Y. (2021). Mushrooms contribution to farm income and the socio-economic conditions analysis of the growers. International Journal of Environment and Climate Change, 466-473. https://doi.org/10.9734/ijecc/2021/v11i1230598

46. Sitotaw, R., Lulekal, E., & Abate, D. (2020). Ethnomycological study of edible and medicinal mushrooms in menge district, asossa zone, benshangul gumuz region, ethiopia. Journal of Ethnobiology and Ethnomedicine, 16(1). https://doi.org/10.1186/s13002-020-00361-9

47. Slamet, A., Nakayasu, A., & Ichikawa, M. (2017). Small-scale vegetable farmers' participation in modern retail market channels in indonesia: the determinants of and effects on their income. Agriculture, 7(2), 11. https://doi.org/10.3390/agriculture7020011

48. Tachabenjarong, N., Rungsardthong, V., Ruktanonchi, U., Poodchakarn, S., Thumthanaruk, B., Vatanyoopaisarn, S., … & Uttapap, D. (2022). Bioactive compounds and antioxidant activity of lion's mane mushroom (hericium erinaceus) from different growth periods. E3s Web of Conferences, 355, 02016. https://doi.org/10.1051/e3sconf/202235502016

49. Wauton, E., Odinwa, A., & Ekeogu, C. (2022). Evaluation of agricultural projects and extension services of the bayelsa state agricultural development programme (adp). Asian Journal of Agricultural Extension Economics & Sociology, 273-284. https://doi.org/10.9734/ajaees/2022/v40i931004

50. Wei, Y., Jiang, C., Wang, Q., Fang, Y., Wang, J., Wang, M., … & Xiao, H. (2022). Biosynthesis of mushroom-derived type ii ganoderic acids by engineered yeast. Nature Communications, 13(1). https://doi.org/10.1038/s41467-022-35500-1

51. Zhang, L., Dong, Y., Liu, C., & Bai, Y. (2018). Off-farm employment over the past four decades in rural china. China Agricultural Economic Review, 10(2), 190-214. https://doi.org/10.1108/caer-11-2017-0212

52. Zied, D., Sánchez, J., Noble, R., & Pardo-Giménez, A. (2020). Use of spent mushroom substrate in new mushroom crops to promote the transition towards a circular economy. Agronomy, 10(9), 1239. https://doi.org/10.3390/agronomy10091239