



# American Journal of Sustainable Agriculture and Rural Development (AJSARD)

VOLUME 2 ISSUE 1 (2026)



PUBLISHED BY  
E-PALLI PUBLISHERS, DELAWARE, USA

## Assessment of Mushroom Production Technologies in Camarines Sur, Philippines

Balbis, F.Jr.<sup>1\*</sup>, Saldo, C.P.A.<sup>2</sup>, Dacuba, R.M.<sup>3</sup>, Falcon, D.V.<sup>4</sup>, Tagum, R.D.<sup>5</sup>, Lovino, D.P.<sup>6</sup>, Cribbe, G.B.<sup>7</sup>, Avenue, R.A.<sup>8</sup>

### Article Information

**Received:** February 12, 2026

**Accepted:** April 10, 2026

**Published:** July 09, 2026

### Keywords

*Economic Viability, Mushroom Growers, Production Technologies*

### ABSTRACT

The case study assessed the mushroom production technologies used by oyster mushroom growers in selected municipalities of Camarines Sur (Districts 3, 4, and 5), and analyzed how technology use aligned with enterprise viability and continuing production constraints. A descriptive explanatory case study approach was applied, where farm visits, interviews, and a structured survey questionnaire were combined to quantify technology adoption, perceived economic viability, and the intensity of production and marketing challenges. Purposive sampling focused on active growers with experience in mushroom production to allow district-level comparisons and to capture practices common under real farm conditions. Growers were generally middle-aged and economically active, operating small production spaces (about 72–74 m<sup>2</sup> on average). Across districts, overall adoption levels were closely comparable (mean  $\approx$  1.76–1.77), indicates that technology uptake was steady but not intensive. Adoption was also selective roughly 62.5% of assessed items consistently fell under low adoption, indicates that practices requiring specialized equipment, higher capital outlay, or advanced process control were less likely to be implemented. The most widely used practices were those that were practical and low-cost, including hot water treatment, manual bagging, simple nipa/bamboo fruiting houses, rice straw-based substrates, and immediate selling of fresh mushrooms. Even though the level of technology intensity was relatively low, the economic viability results were consistently strong and centered around the high rating band, while overall means ranged approximately between 3.12 and 3.18. However, constraints were high overall, with means ranging from 2.95 to approximately 3.13, and the key constraints were based on the lack of infrastructure, equipment, high input costs, and the lack of access to capital and credit. The outcomes indicates that growers are able to maintain economic viability through accessible and low-input technologies, but with regard to the potential to lift quality stability and scale up production, the focus needs to be placed on providing targeted support in terms of infrastructure, access to finance, and extension approaches emphasizing the importance of controlling contamination, substrate use, and even environmental control in general terms.

### INTRODUCTION

The study focused on how research-based mushroom production technologies were positioned to affect the future economic productivity of mushroom growers in selected municipalities of Camarines Sur. With the continued shift in consumer preferences towards health-giving, organic, and sustainably produced foods, edible mushrooms, especially oyster mushrooms, have been identified as a viable business opportunity for rural and peri-urban areas.

Mushroom production in the Philippines remained an economically viable business opportunity for of the low cost of raw materials, specifically agricultural residues, used as substrates in mushroom production, thus lowering farm costs. Mushroom cultivation was often cited as a viable career path since it had minimal space requirements, a short production cycle, and could easily be expanded from a household-based operation to a cooperative-based business. In some regions, the

mushroom industry was cited as a promising sector in rural economic development as of its potential to generate employment, improve rural food security, and generate additional income for small farmers. However, despite its potential, many mushroom farmers remained hampered by technical and operational challenges. These would include a lack of proper training with esteem to sterile practices, unstable production processes, inadequate access to modern cultivation technology, and limited capital to improve infrastructure and input quality. These would often lead to increased risks of contamination, reduced production efficiency, and the reduced capacity of mushroom farmers to produce acceptable quality on a consistent basis.

In Camarines Sur, the issues were more apparent when taken in the situation of the reality of highly variable production conditions, such as temperature, humidity, and ventilation factors that were important for mushroom growth. Indoor production systems that were controlled

<sup>1</sup> College of Agriculture and Natural Resources, Central Bicol State University of Agriculture, Philippines

<sup>2</sup> Research Division- Central Bicol Experiment Station, Department of Agriculture Regional Field Office 5, Philippines

<sup>3</sup> College of Agribusiness, Governor Mariano E. Villafuerte Community College-Garchitorena, Philippines

<sup>4</sup> Office of the Municipal Agriculturist, Local Government Unit of Paracale, Camarines Norte, Philippines

<sup>5</sup> Albay Provincial Agricultural Office, Cabangan, Camalig Albay, Philippines

<sup>6</sup> College of Agriculture and Natural Resources, Central Bicol State University of Agriculture, Philippines

<sup>7</sup> Office of the Municipal Agriculturist Office, Local Government Unit of Labo, Camarines Norte, Philippines

<sup>8</sup> Office of the City Agriculturist, Local Government Unit, Legazpi City, Albay, Philippines

\* Corresponding author's e-mail: [fortunato.balbis@cbsua.edu.ph](mailto:fortunato.balbis@cbsua.edu.ph)

or semi-controlled were generally observed as important mushrooms needed carefully controlled environmental conditions to optimize fruiting and minimize physiological stress.

In consideration, the study was emphasized evaluation the impact of the adoption of new research innovations especially in spawn production methods, substrate development from available agro-wastes, climate-regulated fruiting chambers, and post-harvest technologies to determine the extent to which the adoption of new research innovations affected farm outcomes. Findings from existing literature indicated that spawn quality and spawn materials improvement resulted in increased mycelial growth and accelerated colonization, which could positively affect crop performance and production risk. Similarly, research findings showed that mushroom growth and production were significantly affected by substrate formulation, and that agricultural by-products such as straw, bagasse, and sawdust mixtures could be optimized to maximize biological efficiency at a reasonable cost. From a systems point of view, even simple and low-cost environmental control technologies such as better ventilation systems and sensor-based control systems helped in stabilizing production by enabling farmers to better control the environment surrounding the crop.

Eventually, through the focus on some selected municipalities where the cultivation of mushrooms was more active, the case study hoped to shed light on how research-driven technologies could enhance productivity, increase net returns, minimize losses during production, and improve the overall competitiveness of mushroom enterprises in Camarines Sur. The results of the study formed the basis for interventions that could help mushroom growers improve from survival to more profitable levels of mushroom production.

### Objectives of the Study

#### General Objective

To assess the mushroom production technologies adopted of mushroom growers in Camarines Sur.

#### Specific Objectives

1. To describe the socio-economic profile of the mushroom growers;
2. To determine the mushroom technologies adopted of mushroom growers;
3. To assess the economic viability of mushroom enterprises;
4. To identify challenges encountered of mushroom growers, and;
5. To propose recommendation to improve the mushroom production technologies adopted of mushroom growers in Camarines Sur.

### Theoretical and Conceptual Framework

The research study was grounded on the Diffusion of Innovations Theory by Rogers (2003), which describes the process by which individuals and groups adopt new

technologies based on perceived relative advantage, compatibility, complexity, trialability, and observability. This theoretical approach was useful in explaining the process by which mushroom growers were adopt research-based technologies. Moreover, the Sustainable Livelihoods Framework was used to examine the impact of technological adoption on the improvement of key livelihood assets such as human, social, physical, financial, and natural capital. This approach was examined the impact of technological adoption on the long-term livelihood security of mushroom growers.

The conceptual framework of the case study was identified research technologies as the main independent variable, economic productivity as the main dependent variable, and technology adoption behavior, training, and production as the mediating variables that was determined the overall effect of innovation (Fig. 1).

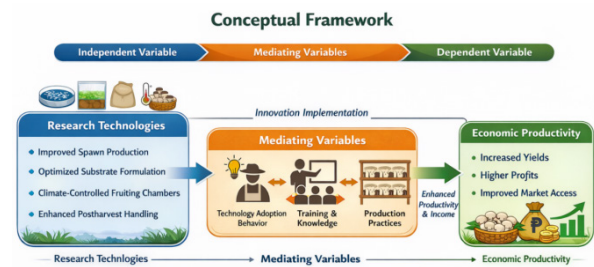


Figure 1: Conceptual Framework of the Study

## MATERIALS AND METHODS

### Research Design

The study employed a descriptive-comparative research design to examine the socio-economic characteristics, technology adoption practices, economic viability, and challenges encountered by mushroom growers across Districts 3, 4, and 5 of Camarines Sur. This design was appropriate as it allowed for the systematic description of existing conditions and the comparison of patterns across different locations.

### Locale of the Study

The study was conducted in three selected districts of Camarines Sur, namely Districts 3, 4, and 5. These areas were chosen due to the presence of active mushroom growers and the relevance of mushroom production as a livelihood activity within these communities.

### Respondents of the Study

The respondents of the study consisted of mushroom growers from the three districts. A purposive sampling technique was used to select participants who were actively engaged in mushroom production. A total of 10 respondents per district were included, resulting in an overall sample of 30 mushroom growers.

### Data Collection Instrument

Data were collected using a structured survey questionnaire developed by the researchers, which

consisted of four major sections: (a) socio-economic and demographic profile, (b) mushroom technologies adopted, (c) economic viability of mushroom enterprises, and (d) challenges encountered by mushroom growers. The variables on technology adoption, economic viability, and challenges were measured using a four-point Likert scale with the following descriptive interpretations: 1.00–1.75 (Low), 1.76–2.50 (Moderate), 2.51–3.25 (High), and 3.26–4.00 (Very High). The questionnaire was pre-tested to ensure clarity, reliability, and appropriateness of the items.

### Data Collection Procedure

Prior to data collection, permission was secured from the concerned local authorities and respondents. The researchers personally administered the questionnaires to the mushroom growers to ensure accurate and complete responses. Necessary instructions and clarifications were provided during the data gathering process. The collected data were then checked, organized, and prepared for analysis.

### Data Analysis

The data gathered were analyzed using descriptive and comparative statistical tools. Frequency counts and percentages were used to describe the socio-economic and demographic characteristics of the respondents, while means were computed to determine the level of technology adoption, economic viability, and challenges encountered. Ranking was applied to identify the most commonly adopted technologies and the most significant constraints.

Additionally, range and variation analyses were utilized to examine differences across districts, particularly in identifying items with the greatest variability. Comparative analysis was further conducted to assess the similarities and differences among Districts 3, 4, and 5 in terms of technology use, economic viability, and challenges.

### Ethical Considerations

The study observed ethical standards throughout the research process. Participation of respondents was voluntary, and informed consent was obtained prior to data collection. Confidentiality and anonymity of the respondents were ensured, and the data collected were used solely for academic and research purposes.

## RESULT AND DISCUSSIONS

### Socio-Economic Profile of the Mushroom Growers

In table 1 showed that the socio-demographics and farm profile of the mushroom growers in Districts 3, 4, and 5, signified that the profile of mushroom respondents was comparable while had some distinctive dimensions in relation to their livelihood and income orientations. The age profile showed that the farmers were of middle age since their average age was 47.4 years old in District 3, 45.2 years old in District 4, and 43.5 years old in District 5. This indicated that the activity was mainly conducted

by people within the economically active age group who have some experience or knowledge of farming.

This result supports recent studies which reported that mushroom production is commonly undertaken by middle-aged individuals who possess prior farming experience and are more capable of managing labor-intensive agricultural enterprises (Singh *et al.*, 2022; Rahman & Hasan, 2023). These studies emphasized that age contributes to both decision-making capacity and risk management in small-scale agribusiness.

Furthermore, the average floor area used in all these districts was more or less similar, which ranged from 72–74 sqm, indicated that the activity was not extensive or dependent on large land areas. In terms of the gender composition, district 4 had a higher male population (7 males compared to 3 females), while districts 3 and 5 had a higher number of females (6 females compared to 4 males), which indicated that the mushroom enterprise might have been balanced but could have depended on location in some instances.

The relatively small production area (72–74 sqm) observed in all districts is consistent with findings of Kumar *et al.* (2021) and Dlamini *et al.* (2024), who highlighted that mushroom production is a space-efficient enterprise that can be practiced even in limited areas, making it suitable for household-level and peri-urban farming systems. This further reinforces the role of mushroom production as a viable livelihood option for smallholders with limited land resources.

In all the districts, the respondents showed certain structural characteristics all educational attainment of the respondents were high school graduate. The uniformity in educational attainment, where most respondents were high school graduates, supports the findings of Ali *et al.* (2021), who noted that basic education is sufficient for adopting simple agricultural technologies such as mushroom cultivation.

Most of them (80%) were married in terms of civil status, and the majority owned the land they used, which indicated stability and possibly reduced insecurity in the space of production. Furthermore, the high percentage of married respondents and land ownership suggests socio-economic stability, which has been identified as a key factor influencing sustained engagement in agricultural enterprises (World Bank, 2022).

In terms of gender participation, the study showed a relatively balanced involvement of males and females, although variations existed across districts. This finding aligns with the work of FAO (2022) and Reyes *et al.*, (2023), which reported that mushroom production is a gender-inclusive enterprise, often providing opportunities for women due to its compatibility with household-based production systems and flexible labor requirements.

In characterizing the mushroom production structure, all the districts exhibited high uniformity in that all the respondents grew oyster mushrooms. The dominance of oyster mushroom production and reliance on self-produced spawn are consistent with studies by Zhang

*et al.* (2021) and Bautista *et al.* (2024), which indicated that oyster mushrooms are widely preferred due to their adaptability, lower production requirements, and ease of cultivation. However, reliance on self-produced spawn may also reflect limited access to certified inputs, which can affect productivity and quality.

Additionally, most of the respondents used self-produced spawns with limited sources of commercial spawns. Livelihood profiles showed in Table 2 that Districts 3 and 5 were characterized as farmer, while District 4 was more identified as vendor. Yet, the main income

**Table 1:** Demographic Characteristics of the Mushroom Growers

Categories	District 3	District 4	District 5
Age	47.4	45.2	43.5
Average Land Area (sqm)	72	74	71.9
Gender			
Male	4	7	4
Female	6	3	6
Average Educational Attainment	High School Graduate	High School Graduate	High School Graduate
Civil Status	Married	Married	Married
Land Ownership	Owned	Owned	Owned
Mushroom Type	Oyster	Oyster	Oyster
Spawn Source	Self-produced	Self-produced	Self-produced

sources were crop farming in Districts 3 and 4, while for District 5, it was mixed farming, which recommended more diversification and perhaps better buffering against single-commodity risks. Primary monthly income for District 4 was within the range of ₱5,001-10,000, while District 3 reported ₱10,001-20,000 and District 5 also reported ₱10,001-20,000, which indicated that relatively higher household income capacity in Districts 3 and 5 compared with District 4.

The secondary livelihood patterns, however, also indicated that the people were mostly into farming as a part-time occupation. The sales earnings of the mushrooms were the secondary source of income. The secondary monthly

income of the people was ranging between ₱5,001-10,000.

In terms of livelihood, the findings showed that mushroom production served as a secondary source of income, complementing primary agricultural activities. This supports the findings of Torres *et al.* (2023), who emphasized that mushroom enterprises are often integrated into diversified farming systems to enhance income stability and reduce vulnerability to agricultural risks.

**Mushroom Technologies Adopted of Mushroom Growers**

Based on the results shown that the overall technology

**Table 2:** Economic Characteristics of the Mushroom Growers

Categories	District 3	District 4	District 5
Primary Occupation	Farmer	Vendor	Farmer
Primary Income Source	Crop Farming	Crop Farming	Mixed Farming
Primary Monthly Income Bracket	10,001- 20,000	5,001- 10,000	10,001- 20,000
Secondary Occupation	Part-time Farming	Part-time Farming	Part-time Farming
Secondary Income Source	Mushroom Sales	Mushroom Sales	Mushroom Sales
Secondary Monthly Income Bracket	5,001-10,000	5,001-10,000	5,001-10,000

mean was almost similar across all three districts under study, 3rd District (1.77), 4th District (1.76), and 5th District (1.76). This implies that a small difference exists (range  $\approx 0.01$ ), thus emphasizing that a similar technology usage environment exists. This implies that the environment under which production takes place most likely had a similar impact on technology usage across all districts from 3 to 5, instead of having different impacts across different districts.

The results indicated that technology adoption levels

were generally low to moderate across all districts, with minimal variation. This finding is consistent with recent studies which reported that smallholder farmers tend to adopt low-cost and easily manageable technologies due to financial and technical constraints (Mwangi *et al.*, 2022; Patel & Singh, 2024). This interpretation was based on Table

The category pattern indicates that growers were generally practicing the core operational steps-more consistent with bagging and basic postharvest handling than capital

**Table 3:** Overall technology mean by district

District	Tech Overall Mean
District 3	1.77
District 4	1.76
District 5	1.76

or facility dependent technologies, such as advanced equipment and controlled environmental systems. The preference for basic technologies such as manual bagging, hot water treatment, and simple fruiting houses reflects a reliance on traditional and labor-intensive practices. According to Chen *et al.*, (2021) and Lopez *et al.*, (2023), these practices remain dominant in developing countries because they require minimal capital investment and are adaptable to local conditions. Moreover, hot water treatment has been identified as a practical alternative

to expensive sterilization systems, especially in resource-limited settings.

These results reflect a production system practically orientated towards low-cost, feasible, locally manageable options while higher-investment technologies remain less utilized showed in Table 4.

However, despite the high-performing practices, the general trend observed was that around 25 out of 40 technologies close to 62.5%, were accounted for in the

**Table 4:** Technology Categories Mean by District

District	Substrate Mean	Bagging Mean	Sterilization Mean	Equipment Mean	Inoculation Mean	Incubation Mean	Fruiting Mean	Temp. Mean	Ventilation Mean	PostHarvest
Mean										
District 3	1.71	2.00	1.75	1.85	1.67	1.67	1.75	1.68	1.67	2.00
District 4	1.73	2.00	1.75	1.75	1.67	1.67	1.75	1.70	1.67	1.90
District 5	1.66	2.00	1.75	1.83	1.67	1.67	1.75	1.66	1.67	2.00

Low adoption category. These indications that most of the technologies presented were not adopted extensively by the growers.

The limited adoption of advanced technologies, such as automated environmental control systems and cold storage, aligns with the findings of FAO (2022) and Kumar & Das (2025), which highlighted that high investment costs, lack of technical knowledge, and limited access to credit are major barriers to technological advancement in

small-scale mushroom production.

There were only a few that were adopted to a Very High level 5-6 items, which signals that there was a selection of technologies that were highly applicable to the farmers while others were underutilized in the improved/advanced aspects showed in Table 5.

Based on the findings showed in table 6, it is clear that the most used technologies among all the districts studied are the ones that the growers can instantly operationalize and

**Table 5:** Frequency distribution of adoption levels (n = 40 technology items per district)

District	Low (1.00–1.75)	Moderate (1.76–2.50)	High (2.51–3.25)	Very High (3.26–4.00)
District 3	25	5	4	6
District 4	25	5	5	5
District 5	25	6	3	6

apply with the available inputs and low capital.

Manual bagging was one of the top-ranking practices, which given its applicability to small-scale production systems that still maintained a largely labor-based system with minimal equipment needs. Similarly, hot water treatment was also highly utilized which shows that as a sterilizing agent, it was a key means of controlling contaminants under circumstances when access to highly expensive and high-pressure sterilization facilities was difficult.

The observed variation in substrate uses and processing equipment across districts is supported by the study of Rahman *et al.*, (2023), which emphasized that technology adoption is highly influenced by local resource availability, including agricultural residues, fuel sources, and infrastructure. This suggests that adoption is not solely dependent on knowledge but also on contextual and environmental factors.

Furthermore, the continued use of simple forms of nipa/bamboo fruiting houses showed a strong preference

towards built infrastructure that matched environmental conditions and still offered functional space, even when it came to fruiting. Looking at postharvest handling, it is apparent that there is a strong bias towards immediate fresh sale that mirrors a marketing strategy that is based on short turnover patterns, which is usually a reflection

of cold storage being a limiting factor and the need to assure postharvest quality through other means.

Technologies with the greatest variation across districts The variable items were mainly in substrate selection and basic processing equipment, where these factors

**Table 6:** Highest-rated technologies per district (top items by mean score)

District	Top technologies (highest means)
District 3	Hot Water Treatment (4.0); Manual Bagging (4.0); Simple Nipa/Bamboo Fruiting House (4.0); Rice Straw Substrate (3.7); Immediate Fresh Sale (3.5); Drum/Kerosene Stove Boiler (3.4)
District 4	Hot Water Treatment (4.0); Rice Straw Substrate (4.0); Manual Bagging (4.0); Simple Nipa/Bamboo Fruiting House (4.0); Immediate Fresh Sale (3.3); Drum/Kerosene Stove Boiler (3.0)
District 5	Hot Water Treatment (4.0); Manual Bagging (4.0); Simple Nipa/Bamboo Fruiting House (4.0); Rice Straw Substrate (3.5); Immediate Fresh Sale (3.5); Drum/Kerosene Stove Boiler (3.3)

are commonly specific to individual sites, depending on supplies accessible at some sites and production capacity of individual households, rather than being affected by training exposure (Table 7).

The differences of means for sawdust and rice straw likely reflected the uneven availability of these materials across locations, including variation in nearby agro-industrial sources, seasonal supply, transport distance, and the practicality of storage and handling. It was observed the differences of used improvised boiling/steaming systems indicates that household-level access to fuel, drums, burners, and locally fabricated units influenced whether growers could maintain routine thermal treatment and

sterilization-related activities. The largest observed ranges (approximately 0.40–0.50) remained relatively significance, indicating that these were incremental differences rather than major shifts in technology use.

Furthermore, the preference for immediate fresh sale reflects limited postharvest facilities, particularly cold storage. This is consistent with findings by Santos *et al.*, (2024), who reported that inadequate postharvest infrastructure leads farmers to adopt rapid marketing strategies to minimize losses.

**Economic Viability of Mushroom Enterprises**

The overall economic viability ratings had consistently high ratings in all the districts. The ratings in District 4 had

**Table 7:** Items with the largest variation across districts (means, min–max, range)

Technology item	Mean across districts	Min	Max	Range
Substrate: Sawdust	2.80	2.50	3.00	0.50
Substrate: Rice Straw	3.73	3.50	4.00	0.50
Substrate: Mixed	1.37	1.20	1.60	0.40
Equipment: Drum/Kerosene Stove Boiler	3.23	3.00	3.40	0.40
Temp/Humidity: Automated Sprinkler	2.40	2.30	2.50	0.20
Postharvest: Refrigeration/Cold Storage	2.43	2.30	2.50	0.20
Postharvest: Immediate Fresh Sale	3.43	3.30	3.50	0.20

the overall mean with the highest value, (3.18), followed by District 3 and District 5, with ratings of (3.16) and (3.12), respectively, though the differences are extremely small, ranging over an overall range of 0.06.

The consistently high economic viability ratings across all districts indicate that mushroom production is a profitable enterprise. This finding is supported by recent studies which identified mushroom farming as a high-

value, low-investment agribusiness with quick returns (Islam *et al.*, 2022; Gupta & Sharma, 2023).

This indicates that all the districts had comparatively comparable results, though with minor differences in the overall ratings (Table 8).

The frequency distribution strongly supported the overall pattern of results across districts. In Table 9, showed that none of the 20 economic viability indicators had

**Table 8:** Overall economic viability mean by district

District	Economic Viability Overall Mean (1-4)
District 3	3.16
District 4	3.18
District 5	3.12

mean scores within the Low Intervals of 1.00–1.75 and Moderate Intervals of 1.76–2.50, respectively. Instead, all item means clustered within the upper response categories, specifically the High (2.51–3.25) and Very High (3.26–4.00) bands. Districts 3 and 4 shown an identical profile, with 11 indicators classified as High and 9 indicators classified as Very High, indicated a stable and consistently positive economic viability assessment across most domains measured.

The clustering of economic indicators within high and very high categories suggests strong overall performance of the enterprise. According to World Bank (2023), diversified agricultural enterprises such as mushroom production contribute significantly to rural income enhancement and livelihood resilience.

District 5 showed a slightly more conservative distribution, with 13 indicators in the High category and 7 indicators in the Very High category, suggested in marginally

**Table 9:** Frequency distribution of economic viability levels (n= 20 items per district)

District	Low (1.00-1.75)	Moderate (1.76-2.50)	High (2.51-3.25)	Very high (3.26-4.00)
District 3	0	0	11	9
District 4	0	0	11	9
District 5	0	0	13	7

lower item-level ratings in a subset of indicators while still remaining within favorable thresholds. Overall, the distribution pattern indicated that economic viability was supported across a broad set of indicators, demonstrating coherence across the scale rather than reflecting isolated strength in only a few items. This concentration of responses in the upper categories implied that the perceived economic viability of the enterprise was generally robust across districts, with only minor shifts in intensity of ratings between High and Very High classifications.

The findings identified that the maximum distance between districts was recorded by Economic Viability Q5 with a mean of 2.83, was identified to be the most sensitive attribute to local conditions. Additionally, a range of 0.6 across a scale of 1 to 4 implied that this attribute related to the economic dimension identified by Q5 did not necessarily display uniformity over districts, possibly due to differences in situation related to enterprises implemented in these districts such as cost structures, market structures, and price stability issues.

The data result in items Q1, Q14, and Q8 had a recorded range of 0.4 and means of 3.27, though these areas were

still ranging under the high to very high, the presence of a range of 0.4 indicated that possibly these areas might have given a different rating compared to others regarding these economic factors.

The Q13 indicates an average level of variation in results, with a mean of 3.30 and a range of 0.3. This indicates relatively stable results with minor differences in districts. Hence, Q10, Q19, and Q17 indicate the lowest level of variation among these questions, with all showing a range of 0.2 and, moreover, relatively high results, with an average for Q10 at 3.40, Q19 at 3.33, and Q17 at 3.20 (Table 10).

However, the variation observed in specific indicators, particularly those related to cost structures and market conditions, aligns with findings by Nguyen *et al.* (2024), who reported that profitability in mushroom enterprises is influenced by input costs, price fluctuations, and access to markets. These variations highlight the importance of localized economic conditions in shaping enterprise outcomes.

These characteristics of the economy, represented by these indicators, followed patterns more in line with those where the findings were not subject to location-

**Table 10:** Economic Items with the greatest variation across districts

ITEM	MEAN	MIN	MAX	RANGE
Economic Viability Q5	2.83	2.6	3.2	0.6
Economic Viability Q1	3.27	3	3.4	0.4
Economic Viability Q14	3.27	3.1	3.5	0.4
Economic Viability Q8	3.27	3	3.4	0.4
Economic Viability Q13	3.30	3.2	3.5	0.3
Economic Viability Q10	3.40	3.3	3.5	0.2

Economic Viability Q19	3.33	3.2	3.4	0.2
Economic Viability Q17	3.20	3.1	3.3	0.2

based constraints. In general, the findings suggested that while most of the economic viability ratings highlighted favorable ratings overall, a limited set of indicators, most notably Q5, highlighted those where greater consideration should have been taken due to the likely presence of variations related to local conditions of production that produced some measured effects.

Additionally, the relatively stable ratings across most indicators suggest that mushroom production systems are resilient to location-based constraints. This is consistent with the findings of FAO (2021), which emphasized that small-scale mushroom enterprises can maintain economic viability due to their low dependency on large-scale infrastructure and external inputs.

### Challenges Encountered of Mushroom Growers

The overall challenge intensity level for all districts was observed shown in Table 11. The overall mean was observed as totally on the higher side for District 5, and for District 3, and District 4, relating more to ~3.13, ~3.03, and ~2.95, respectively. Furthermore, the range was observed as totally lower side ~0.18, indicating that

all districts faced more or less the same environment of constraints. A relatively more constricted environment was observed for District 5 with respect to managing the challenges of production/enterprises, as opposed to other districts.

The study revealed that mushroom growers experienced high levels of challenges across all districts, particularly in terms of infrastructure, input costs, and access to capital. These findings are consistent with recent literature identifying financial constraints and inadequate infrastructure as major barriers in small-scale agricultural enterprises (Dlamini *et al.*, 2024; World Bank, 2022).

Table 12 also reflected this general trend, showing ratings predominantly placed in the High and Very High categories. The district 3 had 10 items rated as High, 2 as Very High, and 1 as Moderate, which indicates that all the constraints are represented at a high level, apart from 1, which was slightly lower than the high level. The district 4 had 7 items rated as High, 3 as Very High, and a further 3 as Moderate, indicates that while there may have been a wide differential between the perceived level of certain issues, they may have still been at a high level

**Table 11:** Overall challenge encountered mean by district

District	Challenges Encountered Overall Mean (1-4)
District 3	3.03
District 4	2.95
District 5	3.13

of importance. The district 5 had their highest rating profile, where 6 items are represented as Very High, 6 as High, and 1 as Low, indicates that perhaps some of the constraints are represented at their highest level, whereas 1 domain may have been represented as being slightly easier.

Table 13 provided item-level summaries as well as indicated where the constraints were varied across locations. Under Infrastructure/house/equipment, it

had an average of 4.00 with no variations since its range was 0.00. Thus, this constraint was critical across all the districts. However, there were other intense operational constraints like the high cost of inputs since its overall mean averaged around 3.37.

The critical issue of infrastructure, which showed no variation across districts, supports the findings of Kumar *et al.*, (2023), who emphasized that inadequate production facilities significantly limit productivity and quality in

**Table 12:** Frequency distribution of challenge intensity (n= 13 items per district)

District	Low (1.00-1.75)	Moderate (1.76-2.50)	High (2.51-3.25)	Very high (3.26-4.00)
District 3	0	1	10	2
District 4	0	3	7	3
District 5	1	0	6	6

mushroom farming.

In addition, access to capital/credit also had a similar overall mean since it averaged around 3.30. High input costs and limited access to credit were also identified as major constraints. This aligns with studies by Rahman & Hasan (2023) and FAO (2022), which highlighted that financial limitations restrict farmers' ability to invest in improved technologies and expand production.

However, constraints relating to technical know-how

had the least overall mean since it averaged around 2.03 with significant variations across the districts. Technical know-how also had the widest spread in relation to skills and competency since it varied across the districts. Interestingly, technical know-how was rated relatively lower but showed high variability across districts. This supports the findings of Lopez *et al.*, (2023), who noted that while basic knowledge of mushroom production is widespread, advanced technical skills vary depending on

**Table 12:** Descriptive statistics by challenge item across districts

ITEM	MEAN	MIN	MAX	RANGE
Challenge Spawn Inoculum Quality	3.1	2.9	3.3	0.40
Challenge Substrate Supply	3.07	2.7	3.7	1.0
Challenge Pest and Disease	3.03	2.9	3.3	0.40
Challenge Climate Environmental Control	3.20	3.1	3.3	0.20
Challenge Technical Know How	2.03	1.6	2.4	0.80
Challenge Access to Capital Credit	3.30	3.0	3.6	0.60
Challenge High Cost of Inputs	3.37	3.2	3.5	0.30
Challenge Infrastructure House Equipment	4.0	4.0	4.0	0.00
Challenge Labor Availability Skill	2.70	2.4	2.9	0.50
Challenge Market Price Fluctuation	3.03	3.0	3.1	0.10
Challenge Competition	3.0	2.8	3.2	0.40
Challenge PostHarvest ShelfLife	2.63	2.5	2.8	0.30
Challenge Govt Extension Support	3.0	3.0	3.0	0.00

access to training and extension services.

Also indicated that market-related constraints were also included in the high category. Market-related challenges, such as price fluctuations and competition, were also identified as significant issues. According to Santos *et al.*, (2024), unstable market conditions and lack of organized marketing systems often reduce profitability for small-scale producers.

Thus, market pressures were an issue even when other production pressure points were high as well. The findings confirm that mushroom growers operate under multiple constraints that are both production- and market-related. These results are consistent with recent global and regional studies emphasizing the need for improved extension support, access to credit, and infrastructure development to enhance the sustainability of mushroom enterprises (FAO, 2023; World Bank, 2024).

**Summary**

This study assessed the socio-economic profile, technology adoption, economic viability, and challenges of mushroom growers in Districts 3, 4, and 5 of Camarines Sur. Results showed that growers were generally middle-aged (43–47 years old), predominantly married, high school graduates, and landowners, indicating a stable and experienced group engaged in small-scale mushroom production. Oyster mushroom was uniformly produced, with reliance on self-produced spawn and limited use of commercial inputs.

Mushroom farming was practiced as a supplementary livelihood. While Districts 3 and 5 had relatively higher income levels and were primarily engaged in farming, District 4 respondents were mostly vendors with lower income levels. Mushroom production served as a secondary income source, contributing to household earnings and livelihood diversification.

Technology adoption was generally low to moderate, with farmers favoring simple, low-cost, and locally available technologies such as manual bagging, hot water treatment,

rice straw substrates, and basic nipa/bamboo structures. Advanced technologies were minimally adopted due to financial and resource constraints.

Despite this, mushroom enterprises were perceived as economically viable across all districts, with consistently high ratings in profitability and sustainability indicators. However, variations in cost structures, market conditions, and price stability influenced economic outcomes.

Major challenges included lack of infrastructure, high input costs, limited access to credit, and inconsistent supply of materials. While technical knowledge was not a primary constraint overall, variations across districts suggested uneven access to training and extension support.

**CONCLUSION**

Mushroom growers in the study areas share similar socio-economic characteristics and operate within small-scale, resource-constrained systems. Mushroom production functions mainly as a supplemental livelihood that enhances income stability rather than serving as a primary enterprise.

Technology adoption is largely influenced by affordability and accessibility, resulting in reliance on basic and low-cost practices. Although economic viability is generally high, the sustainability and expansion of the enterprise are constrained by structural limitations, particularly in infrastructure, financing, and input supply systems.

Overall, the findings indicate that mushroom production has strong potential as a sustainable and income-generating enterprise; however, its growth is limited not by lack of farmer capability, but by systemic and institutional constraints.

Extension and market development efforts should be strengthened by providing practical, low-cost, and standardized training programs that are responsive to the needs and capacities of mushroom growers. These initiatives should focus on improving technical skills in production, postharvest handling, and enterprise

management using locally available resources.

At the same time, market access should be enhanced through the promotion of cluster-based marketing strategies and the establishment of strong linkages with institutional buyers such as schools, public markets, processors, and feeding programs to ensure stable demand and better pricing. Furthermore, fostering peer learning among growers through the documentation and sharing of successful, low-cost practices is highly encouraged to facilitate wider adoption of effective innovations and promote continuous improvement within the mushroom industry.

## REFERENCES

- Ali, M., Hassan, S., & Khan, R. (2021). Adoption of small-scale agricultural technologies among rural farmers. *Journal of Agricultural Extension and Rural Development*, 13(2), 45–56.
- Ballesteros, J. F. (n.d.). Towards consumer-oriented mushroom-based product development. University of the Philippines Los Baños.
- Bandura, I., *et al.* (2022). Effect of different grain spawn materials on *Pleurotus*.
- Bautista, R. M., Cruz, A. P., & Santos, J. L. (2024). Oyster mushroom production systems and input utilization in Southeast Asia. *Asian Journal of Agriculture and Development*, 21(1), 78–92.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Catalma, A. L., & Tanggol, J. Y. (2021). Technology adoption and production outcomes of mushroom growers in Southern Luzon. *Philippine Journal of Crop Science*, 46(3), 54–63.
- Chang, S.-T., & Miles, P. G. (2004). *Mushrooms: Cultivation, nutritional value, medicinal effect, and environmental impact* (2nd ed.). CRC Press.
- Chen, L., Wang, Y., & Li, X. (2021). Traditional and modern practices in mushroom cultivation: A comparative analysis. *Journal of Agribusiness and Rural Development*, 19(3), 112–125.
- Cornell Small Farms. (n.d.). Indoor mushroom production. <https://smallfarms.cornell.edu>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- Department of Agriculture–Bureau of Agricultural Research. (2019). *Mushroom industry roadmap 2020–2025*.
- Dlamini, T. S., Mokoena, M. P., & Nkosi, Z. (2024). Smallholder mushroom production as a livelihood strategy in developing countries. *International Journal of Agricultural Sustainability*, 22(2), 134–148.
- Estrada, A. E., Navarro, P. M., & Barroso, G. (2019). Evaluation of mushroom cultivation technologies and their socio-economic impact on small-scale farmers. *Journal of Agricultural Technology*, 15(3), 125–139.
- Food and Agriculture Organization. (2021). *Mushroom production and marketing systems for smallholder farmers*. <https://www.fao.org>
- Food and Agriculture Organization. (2022). *Gender and inclusive value chains in agriculture*. <https://www.fao.org>
- Food and Agriculture Organization. (2023). *Sustainable small-scale agriculture and rural development*. <https://www.fao.org>
- Gupta, R., & Sharma, P. (2023). Economic analysis of mushroom cultivation as a high-value enterprise. *Journal of Agricultural Economics and Development*, 12(4), 201–210.
- Guragain, D. P., *et al.* (2024). A low-cost centralized IoT ecosystem for enhancing oyster mushroom cultivation.
- Hoa, H. T., Wang, C. L., & Wang, C. H. (2015). The effects of different substrates on the growth, yield, and nutritional composition of oyster mushrooms.
- Islam, M. T., Rahman, M. M., & Hossain, M. S. (2022). Profitability of mushroom farming in developing economies. *Asian Journal of Agricultural Economics*, 10(2), 55–67.
- Kumar, A., & Das, S. (2025). Constraints in adopting advanced technologies in mushroom farming. *Journal of Agricultural Innovation*, 18(1), 23–35.
- Kumar, R., Singh, V., & Patel, N. (2021). Space utilization and productivity in small-scale mushroom farming. *Indian Journal of Agricultural Sciences*, 91(6), 890–895.
- Kumar, S., Verma, P., & Yadav, D. (2023). Infrastructure limitations and productivity of mushroom enterprises. *Journal of Rural Development Studies*, 15(2), 67–80.
- Lopez, G. M., Rivera, P. L., & Torres, E. J. (2023). Knowledge and skill gaps in mushroom production among smallholder farmers. *Philippine Journal of Agricultural Extension*, 29(1), 45–60.
- Miśkiewicz, K., *et al.* (2025). *Agri-food wastes as substrates for oyster mushroom cultivation optimization*. Scientific Reports.
- Mwangi, J. K., Otieno, D. J., & Wambua, J. M. (2022). Technology adoption among smallholder farmers: Evidence from low-cost innovations. *African Journal of Agricultural Research*, 17(5), 620–631.
- Nguyen, H. T., Tran, Q. L., & Pham, D. T. (2024). Market dynamics and profitability of mushroom enterprises in Southeast Asia. *Journal of Agribusiness in Developing Economies*, 14(2), 150–165.
- Patel, R., & Singh, K. (2024). Determinants of low-cost technology adoption in agriculture. *Journal of Agricultural Technology*, 20(3), 101–115.
- Philippine Statistics Authority. (2023). *Philippine agriculture performance report 2022*. <https://psa.gov.ph>
- Rahman, M. A., & Hasan, M. K. (2023). Socio-economic determinants of participation in mushroom farming. *Journal of Rural Livelihoods*, 11(1), 33–47.
- Rahman, M. S., Ahmed, S., & Karim, M. (2023). Resource-based adoption of mushroom production technologies. *International Journal of Agricultural Sciences*,

- 18(2), 89–102.
- Reyes, C. M., & Domingo, S. N. (2018). Smallholder livelihoods and agricultural development in the Philippines. *Philippine Journal of Development*, 45(2), 1–28.
- Reyes, C. M., Dela Cruz, M. L., & Garcia, R. P. (2023). Gender roles in small-scale mushroom enterprises in the Philippines. *Philippine Journal of Social Development*, 15(1), 72–88.
- Reyes, R. G., *et al.* (2014). Status and prospect of the mushroom industry in the Philippines.
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
- Royse, D. J., Baars, J., & Tan, Q. (2017). Current overview of mushroom production in the world. In D. J. Royse (Ed.), *Edible and medicinal mushrooms: Technology and applications* (pp. 5–13). John Wiley & Sons.
- Santos, F. R., Mendoza, J. P., & Villanueva, R. L. (2024). Postharvest handling practices and market strategies in mushroom production. *Journal of Postharvest Technology*, 12(1), 44–58.
- Silva, M., *et al.* (2024). Pre- and postharvest strategies for *Pleurotus ostreatus*. *Foods*.
- Singh, P., Kumar, S., & Yadav, R. (2022). Age and experience factors influencing agricultural enterprise management. *Journal of Agricultural Studies*, 10(3), 120–132.
- Tolentino, A. (2020). Assessing livelihood gains from adopting agri-based technologies among rural farmers in the Bicol Region. *Asia Pacific Journal of Rural Development*, 30(1–2), 97–115.
- Torres, A. G., Ramos, L. F., & Castillo, D. M. (2023). Diversification strategies in smallholder farming systems. *Journal of Sustainable Agriculture*, 17(2), 98–110.
- World Bank. (2022). Enhancing agricultural productivity and rural livelihoods. <https://www.worldbank.org>
- World Bank. (2023). Agriculture and food systems for inclusive growth. <https://www.worldbank.org>
- World Bank. (2024). Rural development and resilience strategies. <https://www.worldbank.org>
- Yin, R. K. (2014). *Case study research and applications: Design and methods* (5th ed.). SAGE Publications.
- Zhang, W. R., *et al.* (2019). Development of a novel spawn (block spawn) for *Pleurotus ostreatus*.
- Zhang, Y., Liu, H., & Chen, Z. (2021). Oyster mushroom cultivation: Practices and economic potential. *Journal of Agricultural Science and Technology*, 23(4), 210–222.