Vol. 16 · March 2014
Print ISSN 2012-3981 • Online ISSN 2244-0445
http://dx.doi.org/10.7719/jpair.v16i1.268
Journal Metrics: H Index = 2 from Publish or Perish

JPAIR Multidisciplinary Research is produced
by PAIR, an ISO 9001:2008 QMS certified
by AJA Registrars, Inc.

Status and Prospect of Mushroom Industry in the Philippines

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ABSTRACT

The mushroom industry in the Philippines has exacerbated since 1995, and the lowest production volume was 355 metric tons (MT) in 2009. Most of the mushroom consumed were imported from the different countries of South East Asia like China, Taiwan, Thailand, Malaysia, Korea and Japan. Growing mushrooms in the Philippines is economically feasible due to low- production cost, abundance of cheap substrates from agro wastes and high demand, which will be profitable to the mushroom growers. The study aimed to assess the production of mushroom in some parts of the Philippines, assess their potentials and introduce the non-sterile fermentation method of growing mushroom to the Philippine mushroom industry. There are ten varieties of edible and medicinal mushrooms grown in the Philippines such as Paddy straw mushroom, Oyster mushroom, Shiitake mushroom, Button mushroom, Ear fungi mushroom, Milky mushroom, Yellowish oyster mushroom, Reishi mushroom, Lion`s mane mushroom, and King tuber oyster mushroom. Supporting the mushroom industry is vital in developing the rural economy, enhancing employment and income opportunity in the rural communities as well as providing income to the small farmers.

Keywords **-** Agriculture, mushroom, characteristics of prospect ten varieties, non-sterile using fermentation, SWOT analysis, Philippines

INTRODUCTION

The Philippines has an ideal environmental condition for mushroom cultivations. It is particularly conducive for growers interested to grow tropical mushrooms. In addition, the warm climate is favorable for mushroom growing, appropriate for training, and it will pave the way for the mushroom growers' better life, and successful mushroom production will be corroborated by them. The Philippine government is preparing a 5-year plan for mushroom industry development. With this plan, more production of mushroom awaits the community that could improve the living conditions of the farmers. Global mushroom production started in the 1800's. There is a high demand of mushroom due to factors like increase in population, market expansions, changing of consumer lifestyle, and improved storage facilities and marketing strategies. The world mushroom production has attained 33.4 million tons in 2007 compared to 26million tons in 2000. China, United States of America and Netherlands rank as the top three producers of mushrooms worldwide. China being the frontrunner in mushroom production, has an industry characterized with high output, great cultivating variety, and diverse cultivation pattern (Yu, 2008), 12 % in the USA, and 8% in the Netherlands. The Fujian edible mushroom industry had an output value that is growing each year, continuously enriching the edible fungus types, and mushroom processing industry developed rapidly (Hui-juan, 2012)**.** The cultivated mushroom industry in Korea is also much larger more diverse (Berch & Ka, 2007).

Pasteurization or sterilization is very important in Oyster mushroom growing. It is often the most costly part in the production since fuel is needed in the steaming or boiling process. Venturing in this business requires a complicated and labor-intensive procedure. It could have been very easy, fast and cheaper if pasteurization or sterilization will not be considered in the cultivation of mushroom (Khan, 2004). Mushroom cultivation could be a significant agricultural activity in the Philippines since the consumption is increasing, and drought is the main problem in the area. With almost half of Philippines's mushroom sales coming from other countries, mushrooms can be considered as high-valued crops in the Philippines. However, some potential growers are becoming concerned about the decrease of mushroom profitability and the future of the mushroom industry in the Philippines.

Hence, this study was conducted to present the prospect of the mushroom cultivation in the Philippines and how it can benefit the marginal farmers.

MATERIALS AND METHODS

Data Collection

Secondary data related to the situation and production of mushroom in the Philippines were collected and assessment on the cost of production of growing oyster mushrooms was conducted in Claveria, Misamis Oriental. The cost analysis of mushroom was done in terms of the fixed and variable costs. Ocular survey was also used to validate some information gathered from the study. The non-sterile fermentation of mushroom production was done in MOSCAT, Claveria, Misamis Oriental using the available resources found in the community.

Data Analysis

The research used the descriptive statistics to answer specific indicators in the status and potential of mushroom industry in the Philippines. The assessment also utilized the SWOT analysis to identify the strengths and opportunities of mushroom production and explain the advantages of mushroom production growing in rural areas in the Philippines.

RESULTS AND DISCUSSION

Situation of Mushroom Industry

According to the Department of Agriculture in 1995, there was an erratic production of mushroom due to the shift of mushroom growers' interest from mushroom to rice owing to the Philippine government's implementation of various programs to boost the rice industry. However, after the production of mushroom reached the minimum level in 2009, the volume has been increasing every year with technical extension helps from DA and local universities. For example in the area of Claveria, Misamis Oriental, a KOICA-COAID project has been initiated to provide trainings and activities for future mushroom farmers.

The mushroom industry in the Philippines is dominated by many small-scale producers. However, there are also several large-scale producers, of which are located around the areas of Tagaytay, Batangas and Baguio City, and in VIS-MIN. Although no statistics is available, this group of producers accounts for about two hundred tons of oyster mushrooms; approximately 20 tons of shiitake mushrooms and 15 tons of button mushrooms produced per year. The country imports around 150 metric tons (MT) of button mushrooms yearly, mostly from Taiwan, China, Thailand, and Japan.

The volume of mushroom production has been decreasing in 1992-2009 because of the intensification of rice production. However, the possibility to increase mushroom production is very visible since there is an increase in consumption and growing consumer awareness about the health benefits of mushroom intake.

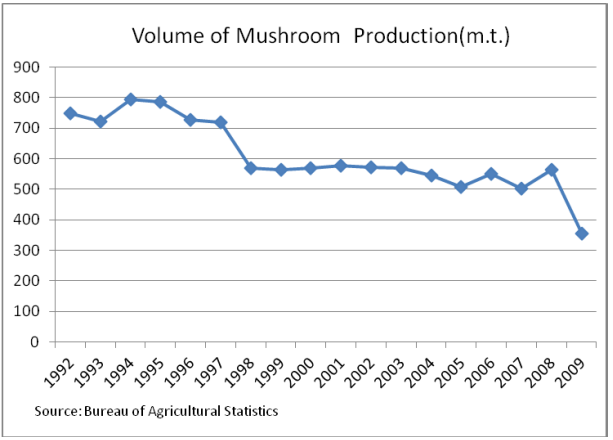

Figure 1. Production of Mushroom in the Philippines

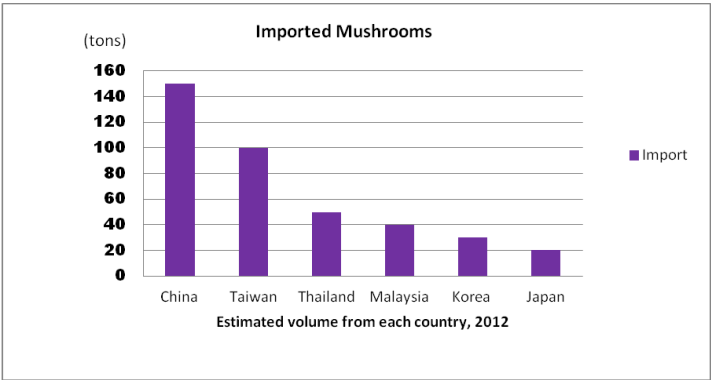

Figure 2. Estimated volume of imported mushrooms from each country in 2012

In the Philippines, the history of mushroom production is very brief. In the succeeding years, with investments coming from public and private sectors for mushroom production, and conducting promotional activities, the production has increased with every passing day. In Figure 1, the mushroom production stayed between 700 tons to 800 tons per year until 1997. Then it declined to 500 tons to 600 tons per year between 1998 and 2008. Then it sharply reduced to 300-400 tons per year in 2009.

In developing countries like the Philippines, mushroom production is not widespread. Usually, mushroom enterprises are small in size. Although there are some entry barriers such as a lack of farm land, droughts, high-mushroom price can push farmers to produce mushroom. Mushroom production in the Philippines is stagnating. Nonetheless, the situation is expected to change intensely according to the various studies done in other developing countries, regarding the technology of producing mushrooms and the marketing structure of the industry (Erkel, 2004). The Philippines mushroom industry is at the verge of explosion with a push of the public sector, because the demand for mushroom will ever grow when the income level of the people increases.

Prospect of Mushroom Industry

At present, the level of self-production for mushroom is 5% compared to the potential yield. To boost the production of mushrooms and to replace imported mushrooms from the leading mushroom producing countries, the Department of Agriculture (DA) is putting up P8 million Mushroom Technology Center (MTC) in Tarlac. The most prominent comparative advantage of mushroom production in the Philippines is that the country has a large number of agro-climatic regions that offer congenially climatic conditions for mushroom cultivation, not to mention. Also, mushroom cultivation has desirable features such as low-cost production, better profit and quick turn over of products. It is in the Philippines' advantage to utilize agro-wastes as substrate materials from byproducts of rice, corn and others. These materials are relatively inexpensive, free from pollution and organic food. Another comparative advantage is the abundance of cheap labor.

The Philippines has available and abundant source of various raw substrate materials. Among them are paddy straws, sawdust, corn cobs, bagasse, banana leaves, chicken manure, lime, cassava wastes, and de-oiled cake. In almost all the regions, these materials are relatively inexpensive when compared with international prices. The Philippines has a large number of agro-climatic regions that offer congenially climatic conditions for mushroom cultivation. There

are cheap labor, low-cost production, high profit and quick return that leads to the improvement of the mushroom business in the Philippines. The increase of mushroom consumption is positively related to the economic growth. The increase in consumer needs and demand for healthy, quality organic products will drive the development of the mushroom industry in the Philippines.

Table 1. Estimated potential production of mushroom (metric tons per ha)

	Products(tons)	Agro wastes(tons)
Palay	4.89	2.44
White Corn	1.95	0.98
Yellow Corn	4.58	2.29
Total	11.42	5.71

*Assumption: Harvest is equal to agricultural wastes left in the field

*Source: DA

Table 1 shows that the average yield of each crop per hectare is 11.42 tons while the total and usable substrates is 5.71 tons for mushroom. Usually, the weight of the mushroom produced is equal to the weight of substrates.

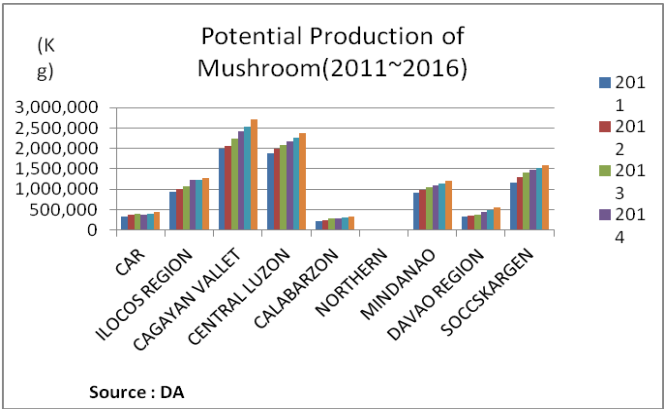

Figure 3. Estimated Potential Production of Mushroom (Kg/Regions/Years)

Figure 3 above shows the potential production of mushroom for 2011-2016 in various provinces of the Philippines. It shows that there will be an increase in mushroom production each year.

List of ten strategic mushroom varieties in Philippines in the light of profitability and adaptability

There are two kinds of target mushrooms. For edible mushrooms: Paddy straw mushroom, Oyster mushroom, Shiitake, Button mushroom, Earfungi mushroom, Milky mushroom, and Yellowish oyster mushroom. For medicinal mushrooms: Reishi mushroom, King tuber oyster mushroom, Lion`s mane mushroom. There is bright future in mushroom production especially on some of the known mushroom species. The contributions from developing countries, such as China, India, Poland, Hungary and Vietnam had greatly promoted the increase in production of mushrooms worldwide. The outlook for many of the identified mushroom species is bright. Edible mushrooms are high in nutritive and medicinal value and are fitted to every person of different countries, nationalities, age groups and faiths (Han et. al. 2008).

Experiments and studies have found verifications regarding the nutritional and medicinal uses of mushrooms. The benefit of mushrooms was confirmed in one of the trials performed for HIV/AIDS patients that showed very promising results. Recent advancements in the mushroom industry generally have promoted production capacities, innovations in cultivation technologies, improvements to final mushroom goods, capitalizing on mushrooms' nutritional and medicinal properties, and utilizing mushrooms' natural qualities for environmental benefits (Chang, 2006).

Characteristics of the prospect ten different Mushroom varieties in the Philippines

Table 2 presents the optimal growth temperatures and attributes of different mushroom varieties. These features vary with the growth stages of the varieties. There are two stages in the life cycle of Pleurotus mushrooms: the vegetative stage and the reproductive stage. The shift from mycelia (vegetative) growth to the fruit body formation (reproduction) phase needs stimuli. These stimuli include sudden changes in temperature, moisture in the environment, gas concentration, light and nutrient found in the substrates, and physical stimuli. An abrupt drop in temperature is much suited to induce fruiting for most mushrooms. The oyster mushrooms thrive best at an optimal temperature of between 10 and 18°C while *P. cornucopiae* and *P. cystidiosus* perform best even at 30°C. Farmers must take into account the CO_2 concentrations in the substrate containers during spawn run and during fruit body development.

Table 2. Optimal growing conditions for various mushrooms

	Vovariella volvacea	*Pleurotus sajor-caju*	*Lentinus edodes*	*Agaricus bisporus*	*Auricularia auricular*	*Calocybe indica*	*Ganoderma lucidum*	*Peurotus Tuber regium*	*Hericium erinaceus*	*Pleurotus cornucopiae*
Spawn run (°C)	30	10-35	23-25	23-25	25-33	25-35	10-38	28-30	22-25	20
Premordial Formation (°C)	28-35	18-24	10-20	15-17	15-25		24-32	25	18-22	
Fruiting body Production (°C)	30-35	20-28	15-20	15-17	20-28	30-35	26-32	25-30	21-24	24-26
CO_2 conc. (ppm)	< 1000	< 1000	< 800	< 2000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
Optimum season	year-round	Summer	Spring	Autumn	Spring, Autumn	year-round	year-round	year-round	Autumn	Autumn

Table 3 shows the ten varieties of edible and medicinal mushrooms such as Reishi (*Ganoderma lucidum*) and lion`s mane (*Hericium erinaceus*). These ten varieties of mushroom are recommended for cultivation in the Philippines. Most of these mushrooms suit the climatic condition of the Philippines except for Shiitake and Button Mushrooms, which grow in low-temperature condition.

Table 3. Available varieties of mushroom cultivation in the Philippines

Common name	Scientific name	Tagalog name
Paddy straw mushroom	*Vovariellavolvacea*	Kabutengdayami(saging)
Oyster mushroom	*Peurotusostreatus*	None
Shiitake	*Lentinusedodes*	Kabutengkahoy
Button mushroom	*Agaricusbisporus*	None
Ear mushroom	*Auricularia auricular*	Tengang-daga
Milky mushroom	*Calocybeindica*	None
Reishi mushroom	*Ganoderma lucidum*	None
King Tuber oyster mushroom	*Peurotus tuber regium(Fr.)*	None
Lion`s mane mushroom	*Hericium erinaceus*	None
Yellowish oyster mushroom	*Pleurotuscornucopiae*	None

Paddy straw mushroom: *Vovariella volvacea* has good taste and suits the most high-temperature areas. It needs four to five days to mature and is most successfully grown in subtropical climates with high annual rainfall. Mixed straw and fowls manure can be used to grow this type of mushroom. Oyster mushroom: *Pleurotus* is also called oyster, abalone, or tree mushrooms, and are considered the widely cultivated edible mushrooms in the world. They are suitable for non-sterilizing cultivation, have high vitality, and resistant to pests and diseases.

Shiitake mushroom: *Lentinusedodes* is an edible mushroom and believed to have medicinal uses in some forms of traditional medicine. Lentinan is manufactured as an anti-cancer medicine. It is a high-income crop with good taste. It can be cultivated year-round using sawdust in recent years. Button mushroom: *Agaricusbisporus* is considered the most widely consumed mushrooms in the world. It has a closed cap with either pale white or light brown flesh. It is essential for cooking. This mushroom requires high nitrogen. Ear mushroom: *Auricularia auricular* can be found throughout the year in temperate regions worldwide. The fungus contains high-dietary fiber. It cures constipation and has a beauty effect. Logs and sawdust are used to culture ear mushroom.

Milky mushroom: *Calocybeindica* is an intense interest in the Philippines, as well as in the world in recent years. Its shape is similar to the button mushroom. It grows in a tropical climate. Sawdust is used as substrate to cultivate milky mushrooms. Reishi mushroom: *Ganoderma lucidum* is also known as mushroom of immortality and is the leading medicinal mushroom in China. There are antler form and flat form. Antler form contains higher bitter taste compared to the flat one. In particular, antler reishi has high-value for ornamental pot-planting as well as the value of medicinal. It can be grown year-round in a tropical area like the Philippines. It has a long-term retention when dried. It thrives on logs and sawdust.

King Tuber oyster mushroom: *Peurotus tuber regium(Fr.)* is originated from Nigeria, Africa. It grows well in high temperatures of 35°c. The people who use this mushroom as food and medicine collect the sclerotia from the wild as hunger crop. It is grown in the ground like sweet potato. King oyster mushroom is the third popular type of mushroom produced and eaten in Taiwan. Lion`s mane mushroom: *Hericium erinaceus*is an edible mushroom (Medical Mushrooms .net, 2014) and medicinal mushroom. It contains substances found responsible for reducing blood sugar and regulating lipid levels in the blood. This mushroom apparently contains antioxidant properties. Scientists are trying to determine

the influence of this mushroom on cases of dementia. Mushroom growing is relatively simple.

Yellowish oyster mushroom: *Pleurotuscornucopiae*- Among the oyster mushrooms, it grows well at relatively high temperature. The pileus colored with yellow, a functionality that is used as coloring. This mushroom is well-accepted by mushroom growers recently.

Table 4. Production cost of oyster mushroom

	Quantity	Price(pesos)	Oyster Mushroom
GROSS INCOME			30,000 PESOS
Expected yield per month	300kg		
Average Price per kg			100 PESOS
TOTAL COST			13,905 PESOS
Labor	6	300	Php1,800
Straw	300kg	1	Php300
Plastic bags(7X14")	600pcs	0.675	Php405
Spawn(1kg/bag)	15bags	150	Php2,250
Chemicals			Php150
Construction			Php9,000
(floor area of 10m^2)			
NET INCOME			Php16,095

The cost of oyster mushroom cultivation differs according to areas and the manner of producing it, yet it is less expensive compared to other cash crops. The less cost of cultivating mushroom is attributed to its small space requirement and inexpensive raw materials used (Celik & Peker, 2009). Oyster mushroom cultivation is more advantageous to farmers with crop plantation since they no longer buy substrate materials, and can utilize low-cost structures for mushroom cultivation on a seasonal basis.

Non-sterile fermentation substrate using microorganisms' Mushroom cultivation

The fermentation tank size was made at 2m width and 1.5m height. The bottom of the tank was slanted to drain water, and made the drain valve outside. The tank was filled with straws up to 2/3 of tank height and was pressed tightly to the bottom of the tank. It was then filled with water until the substrates were submerged sufficiently. Water was drained in two ways: 1) keep it submerged overnight with the drain value open, or 2) press the submerged substrates by foot or another instrument and then drain. Once drained, the substrate was adjusted to 65% moisture content by pressing it by foot. Rice bran was mixed to substrate evenly at 5-15%. Rice bran is good for fermentation and yield of mushroom, but the more rice bran is added, the higher is the chance of disease to develop. If rice bran is not added, the chance of disease development is reduced, however, yield will also be reduced. After pressing the substrate well, it was covered with vinyl sheet for 3-5 days. Then, the substrate was turned over 2-3 times to produce a good substrate. The fermentation method is easier, more convenient and less expensive.

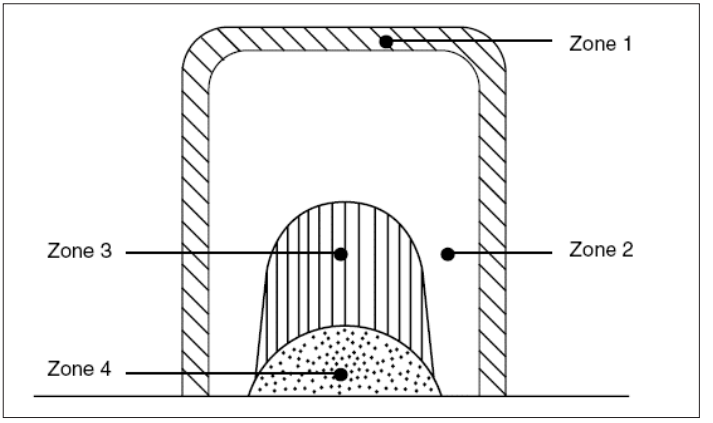

Figure 4. Diagrammatic representation of zonation in a compost heap

Legend:
Zone 1- temperature approximately 35˚C, well-aerated, dry, under composed;
Zone 2 - temperature 55 to 60˚C, well-aerated, decomposed, white flecks of firefang fungus clearly visible;
Zone 3 - temperature 70 to 80˚C, aeration restricted; and
Zone 4 – temperature approximately 35˚C, yellow, foul-smelling, anaerobic.

The non-sterilized method of mushroom production follows these steps: 1) two containers will be filled with 100L of water; 2) soak the wheat straw in one of the containers; 3) dissolve 5kg of limestones to the other container; 4) add the soaked wheat straw to the limestone solution; 5) add 4kg of wheat bran or rice bran and mix thoroughly. Spread the remaining 10kg of dry limestone; 6) pour the mixture of wheat straw and rice bran inside the brick circle, pour water and then cover the substrate with a plastic sheet to conserve the heat, gas and humidity; 7) make shelf bricks on the floor; 8) sprinkle spawn on the substrate; 9) spread 1kg of the yellow pulse powder on the substrate; and 10) cover the shelf with a plastic sheet.

Ground shelf for mushroom production

To make shelf for the mushroom production, dig the ground of growing house into 5~10cm depth, 60~90cm width. Length may vary. Make a furrow evenly then spread the vinyl on the bottom of it. Crush the spawn into a soybean size. Scatter a little amount of the spawn on the vinyl. Put the substrate fermented to the furrow with 10~20cm depth. In the case of having enough spawn, the spawn can be mixed with the substrate. In the case of having not enough spawn, only those not showing on the surface of the substrate may be inoculated. Especially, harden the surface of substrate and spawn. Cover the vinyl (make needle hole with 2cm diameter in all directions) on the surface of spawn. It is better to manage the shelf at 15~20°C for 2~3 days limited because mycelia respiration heat can rise during that time, but in case of small size incubation, room temperature is no problem. It will take 3~4 weeks to incubate completely depending on the substrate amount. Incubation period does not need light yet it requires high humidity such as sprinkling water on the floor and low temperature. The mushroom can be harvested in the dry weight of substrate at least.

SWOT Analyses of Mushroom Production in the Philippines

Table 5. The opportunity of mushroom production in rural areas requires an SWOT analysis

Strengths	Weaknesses
• Cheap labor fee • Abundant substrates for mushroom production • Clean, free environmental pollution and organic food • Increasing of mushroom consumption depending on the economic growth • Low-cost cultivation, bigger income and fast return of investment • Small scale and fragmented agricultural holdings • Insufficiency of capital and financial resource	• Lack of technological development on mushroom production • Insufficiency of rural infrastructure and modernization requirements • Inadequacy of mushroom training and extension services and cooperation • Problems of efficiency in marketing activities
Opportunities	**Threats**
• Nonsterilization by fermentation • Increasing consumer needs and demand for healthy, quality and organic products • Development trends of the mushroom industry • Increasing tendency for demand of mushroom, • Enhanced opportunities to access foreign markets • Progress in production, and processing technologies	• Increasing pressure of rapid urbanization, Industrialization (automatic bottle cultivation) • Rising input prices in the world • Changing trend in agricultural support policies • Migration of young people from rural areas and ageing population • Growing intra and inter-regional development disparities

Strengths. The advantages of growing mushrooms are low-cost production, abundant substrates such as straws and corn cobs, high profit and quick return.

Weaknesses. There are some weakness in mushroom production such as inadequacy of growing mushroom training extension services and cooperation. Other is lack of technological development on mushroom production.

Opportunities. There are some opportunities, one of these is the application of non-sterilization method by fermentation. The other is development trends of the mushroom industry and the tendency for demand of mushroom.

Threats. There is the threat of rising input prices in the world. Also, there is the increasing pressure of rapid urbanization and development.

The study used secondary data to present the figures on the volume and the cost of producing mushrooms and that the non-fermentation method of preparing substrates for mushroom growing is not yet widely practiced by

farmers. In this case, there is a need to make further investigation on the potential of mushroom production in the community.

CONCLUSIONS

Mushroom is the right crop which can contribute much to poverty alleviation due to its low set-up cost, high-price margin and quick returns. Since it requires cheaply agricultural wastes and relatively small space make mushroom growing more accessible for the poor and landless farmers. With the use of non-sterile fermentation method, mushroom growing would be much easier, faster, and economical. In addition, it provides the growers high nutritional value food and livelihood. Therefore, in a capital scarce, but labor abundant countries like the Philippines, the suitable technique is non-sterile method using fermentation for a profitable source of income for the mushroom growers.

There are many remarkable ecological advantages in mushroom cultivation. One is the efficient re-integration of agricultural residues such as manures, straws, sawdust and others. The spent mushroom substrate can be utilized either as feed to animals or as compost for use in the farm.

RECOMMENDATIONS

Based on the results of the study, the mushroom industry must be strengthened to maintain its vibrance and to further its development for the rural economy. Mushroom cultivation could potentially contribute to increasing and diversifying business and employment opportunities in the rural areas especially the small farm growers.

Mushroom production technology should be introduced to the marginal and landless farmers to get an advantage of its feasible practices and quick return of investment. The local government, the Department of Agriculture as well as the academe could support the program by providing trainings and seminars to interested farmers.

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