Mushroom Cultivation

An Effective Means For Poverty Alleviation

Zambia Agribusiness Society

Printed and bound in Zambia

First edition

Mushroom Cultivation: An Effective Means For Poverty Alleviation

Introduction

Mushroom cultivation has been evaluated as an effective means for poverty alleviation in developing countries due to its possibility of low cost production, high profit and quick return.

What is Mushroom?

A mushroom is defined as "*a macrofungus with a distinctive fruiting body which can be either epigeous or hypogeous. The macrofungi have fruiting bodies large enough to be seen with the naked eye and to be picked up by hand*" (Chang and Miles, 1992). In a narrow sense, the word mushroom also refers only to the *fruitbody*.

Mushrooms used to be classified into the Kingdom Plantae, but now they belong to the Kingdom Fungi due to unique fungal characteristics which draw a clear line from animals or plants. Unlike green plants, mushrooms are heterotrophs. Not having chlorophyll, they cannot generate nutrients by photosynthesis, but take nutrients from outer sources. Most mushroom species are under the Basidiomycota and Ascomycota, the two phyla under the Kingdom Fungi (Table 1).

Table 1. Kingdom Fungi

Ascomycota	Sac fungi (yeast to large cup fungi)
Basidiomycota	Higher fungi (toadstool, puffball, bracket fungi)
Zygomycota	Molds, mycorrhizal fungi and soil decomposers
Chytridiomycota	Primitive fungi, chytrids
Deuteromycota	Asexually reproducing fungi

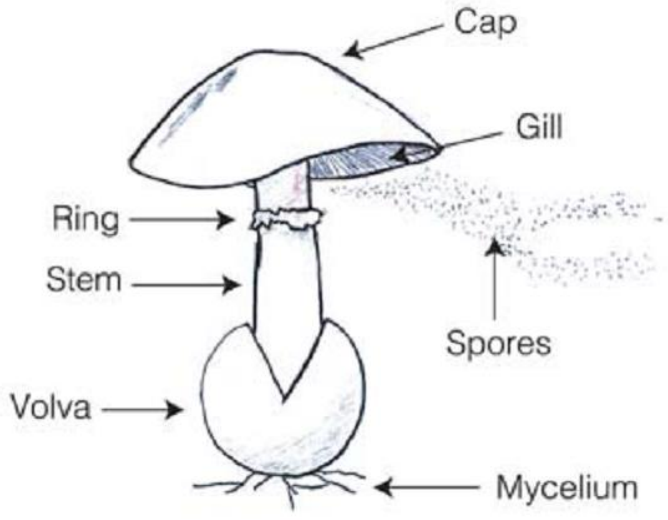


Figure 1. A Mushroom Plant

Mushrooms breed by spores (seeds for plants). Under the proper conditions, spores germinate into hyphae (collectively, mycelia). Mycelia are filamentous and generally unseen with the

naked eye. Germinated hyphae form primary mycelia, and then secondary mycelia through plasmogamy (hyphal fusion). They accumulate nutrients from the substrate (soil for plants) and colonize substrate. When stimulated by temperature, humidity, etc., the mycelial colony forms pins under certain conditions and grow to fruitbodies (fruits for plants). Young fruitbodies are called pins (buds for plants). Pins differentiate into a cap and stem forming fruitbodies.

Mushroom cultivation requires enough understanding on the optimal growing conditions of each mushroom species and how to make favourable environment for both vegetative and reproductive growth of mushrooms.

Three Factors of Mushroom Cultivation

1. **Spawn**

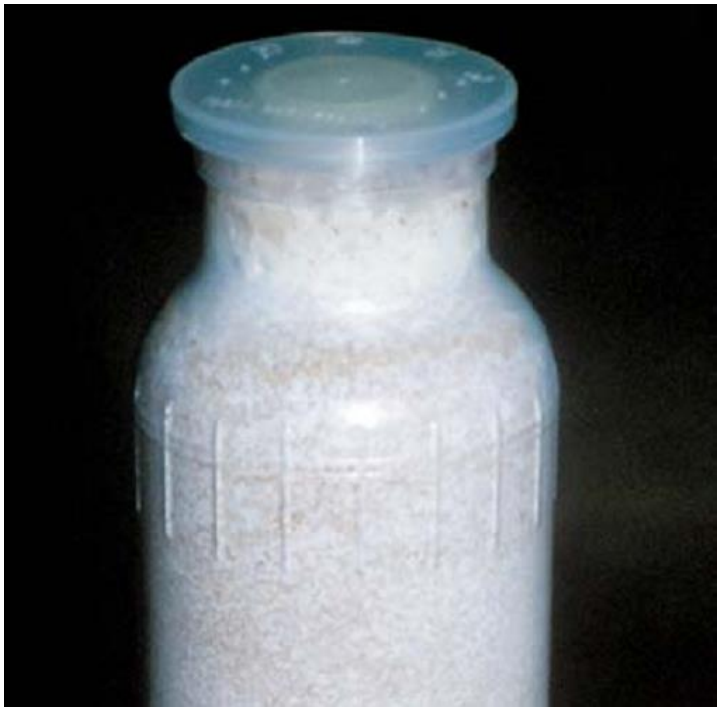


Figure 2. Sawdust spawn

What spawn is to mushroom is like seed is to crop. Unlike spore, *spawn is already at its mycelial stage growing on its own substrate such as sorghum, barley or sawdust*. The life cycle of mushroom starts from spores, but growers inoculate mycelial origin spawn rather than spore origin spawn because of possible variations and mutations. The quality of spawn is one of the most decisive factors for successful crop.
Therefore, growers need to use qualified spawn for commercial production. Spawn should maintain the strain characteristics and is propagated by subcultures. New strains are developed with genetic methods such as variation and mating. The various types of mushroom spawn include grain, sawdust, plug and liquid

2. **Substrate**

Mushrooms can be classified as 3 categories by their tropic pattern; saprophytes, parasites or mycorrhizae. The most commonly grown mushrooms are saprophytes, decomposers in an ecosystem growing on organic matters like wood, leaves and straw in nature. Raw materials

can be used as substrate for primary decomposers such as oyster mushroom and enokitake which have lignocellulosic enzymes. On the other hand, secondary decomposers like button mushroom or straw mushroom require substrate degraded by bacteria or other fungi.
Mushroom requires carbon, nitrogen and inorganic compounds as its nutritional sources and the main nutrients are carbon sources such as cellulose, hemicellulose and lignin. Thus, most organic matters containing cellulose, hemicellulose or lignin can be used as mushroom substrate. Examples are cotton, cottonseed hull, corncob, sugarcane waste, sawdust, and so on. However, demanded amount of each nutritional sources differs according to mushroom species. For example, button mushroom (*Agaricus bisporus*) requires relatively high nitrogen source, so the optimal C/N ratio of button mushroom compost is 17. On the other hand, oyster mushroom and shiitake require less nitrogen and more carbon source. Mushroom mycelia secrete digestive enzymes into the substrate and absorb the dissolved nutrients. Cellulose, the main nutritional source of mushroom is one of the most abundant organic matters on earth, but its digestive enzyme, cellulase is owned by several microorganisms including fungi.
Here comes the reason mushroom is considered an important food source. Mushroom is the only one by which cellulose is dissolved and absorbed and transformed into food for mankind. Mushroom is also influenced by acidity of substrate. The optimal pH value of substrate ranges from 6 to 8, varying with mushroom species.

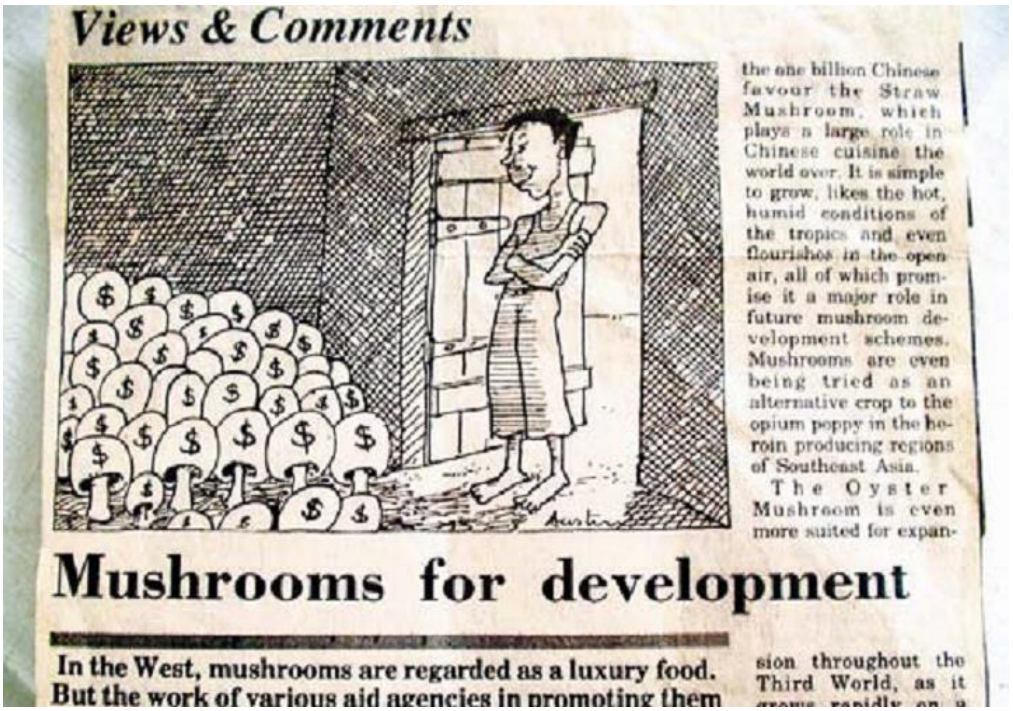
3. **Environment**

The last important factor for mushroom growing is providing an appropriate environment both for vegetative and reproductive growth. Not being protected by a skin layer, fungi are easily affected by their growing conditions. So it can be said that the success or failure of mushroom cultivation depends on the control of growing conditions.
Environmental factors affecting mushroom cultivation include temperature, humidity, light and ventilation.
Optimal levels of them at vegetative stage differ from those at reproductive stage. Mushroom mycelia can survive between 5 and 40℃ depending on the species. Mushroom mycelia grow well with the temperature range between 20 and 30℃. Pins form at 10-20℃, lower than that of mycelial growth by 10℃. Over 80% of the fruitbody is water. Substrate moisture content should be 60-75% and log moisture content, 35-45%. During fruiting, different relative humidity levels, ranging from 80-95%, are needed at the early, mid and latter stage. Though mycelia can grow without light, some species require light for fruitbody formation. Being aerobic fungi, mushrooms need fresh air during growing, but ventilation is more required for reproductive stage.
No matter how well the substrate is colonized, it is useless if it fails in fructification. Therefore creating the optimal conditions for transition from vegetative stage to reproductive stage is crucial to successful mushroom cultivation.

Why Grow Mushrooms

Mushrooms have been part of our human diet since time immemorial. They were used as food even before man understood the use of other organisms. Undoubtedly, mushrooms were one of man's earliest foods, and they were often considered an exotic and luxurious food reserved for the rich. Today mushrooms are food for both the rich and the poor. They can be

grown anywhere as long as the conditions for their growth and cultivation are provided. Available mushroom technologies range in complexity from very high to amazingly low.



Views & Comments

the one billion Chinese favour the Straw Mushroom, which plays a large role in Chinese cuisine the world over. It is simple to grow, likes the hot, humid conditions of the tropics and even flourishes in the open air, all of which promise it a major role in future mushroom development schemes. Mushrooms are even being tried as an alternative crop to the opium poppy in the heroin producing regions of Southeast Asia.

The Oyster Mushroom is even more suited for expansion throughout the Third World, as it

Mushrooms for development

In the West, mushrooms are regarded as a luxury food. But the work of various aid agencies in promoting them

Figure 3. Mushrooms for development

Mushrooms have been variously considered as a hedge against famine or a possible cancer cure. They do certainly have enormous potential for feeding third world peoples. In the West, mushrooms are regarded as a luxury food. But in many developing countries of the world, mushrooms can mean cash for the poor (Fig. 3) and a new source of nutrition. Even landless peasants can grow mushrooms as a valuable crop as long as they have the proper technology, the proper substrates, and the planting material called spawn. In some villages of India, it has been reported that farmers are growing mushrooms right in their own homes or immediate surroundings. Villagers growing mushrooms can rapidly begin to bring in more cash than some local landowners.

Figure 4. Fruiting bodies of *V volvacea*

Figure 5. Straw mushroom beds

Figure 6. Harvesting of straw mushroom

Figure 7. Fruiting bodies of oyster mushroom

In some poor countries of Asia, the tropical Chinese straw mushroom (*Volvariella volvacea*) (Fig. 4) is grown in very simple traditional ways. This mushroom likes the hot humid conditions of the tropics and can be cultivated on beds (Fig. 5) made up of agricultural wastes such as straw or banana leaves. Within **2** weeks, fruitbodies are ready to be harvested (Fig. 6).

Figure 8. Oyster Mushroom houses made of grasses

Figure 9. Oyster mushroom growing on sawdust beds outdoor

Oyster mushrooms (*Pleurotus* spp.) (Fig. 7) are even more suited throughout the third world areas that are rich in plant wastes such as sawdust, sugarcane bagasse and others. Moreover, composting–the difficult preliminary step for button and straw mushroom–is not required for oyster mushroom cultivation.

The oyster mushroom growing houses can be constructed of mud as in some villages in India,

or made of bamboo and dried leaves as in most of Asia (Fig. 8). In cooler areas, oyster mushrooms may even be grown outdoors if they are shielded from excessive sun (Fig. 9).

Benefits Derived from Mushrooms and Growing Mushrooms

1) **Nutrition of the mushrooms**

The popularity of mushrooms is still based not on the nutrients that they contain but mostly on their exotic taste and their culinary properties, whether eaten alone or in combination with other foods. It is not well known that mushrooms are full of nutrients and can therefore make a very important contribution to human nutrition.

2) **As health food and medicinal**

For the past 20 years, interest in the medicinal aspects of mushrooms has greatly been stimulated by the large number of scientific studies conducted on mushrooms. Folklores have provided clues for potential sources of medicine from mushrooms as well as from herbal plants. Using modern approaches, scientists have isolated and identified specific components that can either destroy or at least debilitate three of mankind's killer diseases: cancer, heart disease and AIDS. As a result, a vast body of scientific literature concerning mushrooms has been published since the 1970s, mostly in hospitals and research institutions in Europe, Japan, China and the United States.

3) **Use of agricultural wastes as substrates**

Mushrooms are grown on some organic substrates, mostly waste materials from farms, plantations or factories.

4) **Income and job generation**

Mushroom growing is labour-intensive, and for countries where jobs are scarce, mushroom growing can create jobs both in semi-urban and rural areas. In fact, some technologies can use family labour thus providing all members of the family with employment.

5) **Resulting compost used for soil conditioner and animal feed**

The used compost that remains after harvesting mushrooms may still be recycled for use as animal feeds and soil conditioner.

Conclusion

In conclusion, among the three factors, the most important is environmental control. By maintaining optimal conditions at each growing stage and for each species, growers can produce the desired yield of quality mushrooms.

Glossary

• **Epigeous:** Growing on (or close to) the ground.
• **Hypogeous:** Growing underground.
• **Plasmogamy:** Fusion of cells or protoplasts without fusion of the nuclei, as occurs in higher terrestrial fungi. Nucleus fusion is called *karyogamy*.
• **Heterotroph:** An organism that cannot synthesize its own food and that is dependent on complex organic substances for nutrition. Most organisms except green plants (autotrophs) are heterotrophs.
• **Saprophyte:** An organism which grows on and derives its nutrient from dead or decaying organic matter.
• **Parasite:** An organism that grows, feeds, and is sheltered on or in a different organism while contributing nothing to the survival of its host.
• **Mycorrhiza:** The symbiotic association of the mycelium of a fungus with the roots of

certain plants, such as conifers, beeches, or orchids.
• **Aerobe:** Organism that is living or occurring only in the presence of oxygen.

References

Fungi Perfecti
Growing Mushrooms the Easy Way
Teagsac-Irish Agriculture & Food Development Authority
HRI mushroom research
Mushroom Council
Mushroom Cultivation and Marketing
Mushroom
Mushroom Growers Handbook 1 – Oyster Mushroom Cultivation
Mushroom Growers Handbook 2 – Shiitake Cultivation