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BUTTON MUSHROOM

PRODUCTION GUIDE

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LEA
LOCAL ENTERPRISE AUTHORITY

BUAN CONSULT

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Cover Designed by
The Brightside Agency
P O Box 1416, Jwaneng
brightsidebw@gmail.com
(267) 76 855 262/ 75 724 770

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Local Enterprise Authority
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SUMMARY

The button mushroom production guide details the button mushrooms production process from start to finish including all structural requirements and inputs over a 14- 15 weeks production cycle. The key requirement for button mushroom production is the compost which is used as the growing media. This guide provides the two composting methods; the long and short composting which ranges between 30 to 19 days prior to the commencement of mushroom production. Farmers who can access good quality compost have an option to buy. The quality of the compost determines the efficiency and profitability levels in a button mushroom enterprise. The mushroom common pests and diseases are also identified along with their management measures. Production of button mushroom is suitable for all areas of the country as production is done in structures. Where temperature control facilities are available, production can be done throughout the year. This guide is suitable for use by smallholder and backyard farmers who have undergone some basic training of mushroom production.

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BUTTON MUSHROOM PRODUCTION IN BOTSWANA

Button mushrooms are vegetative forms of fungi and the most popular mushroom variety grown and consumed the world over. The most common species being grown is the white button mushroom(Agaricus bisporus) belonging to Class Basidiomycetes and Family Agaricaceae.

Button mushrooms are economically important as a protein-rich source food that can be sold fresh, canned and used to make other food products such as soups and sauces. In addition to protein (60-70%) mushrooms contains all the essential amino acids and has medicinal properties.

Cultivation of button mushrooms (A.bisporus) started in the sixteenth century. Large scale white button mushroom production is centered in some parts of Europe, North America (USA, Canada) and Asia (mainly China and India). In Africa, countries such as South Africa, Namibia and Zimbabwe have been producing mushrooms for decades. In Botswana, there is abundance of agricultural wastes which are required for mushroom production.

There is high demand for button mushrooms in Botswana, as it is the world over. White button mushrooms account for about 45% of the total mushroom production. A big gap exists between the demand and supply position of white button mushrooms in Botswana. Botswana has relied on imports for button mushrooms despite the increasing demand for the product. The trend in import of mushrooms in Botswana is depicted in table 1.

Table1: Botswana's mushroom (fresh/chilled/canned) imports by country of origin in 2022

Country of Origin	Trade Value 1000USD	Quantity (Kg)
South Africa	987.81	278861
Namibia	0.75	93
Uganda	0.28	11
Zambia	0.02	20
Zimbabwe	0.02	1
China	0.00	1

Source: World Trade Integrated Trade Solutions, 03/10/2024

Table 2: Aggregated Botswana's Mushroom imports in 2021-2023

YEAR	2021	2022	2023
IMPORTS (PULA)	11,031,611.10	12,049,663.23	14,283,551.01

Source: Statistics Botswana, 26/08/2024

Based on table 1 and 2, that show high import values, the possibilities of local production of button mushrooms need to be explored. In addition, the recent inclusion of this crop in the list of crops banned from being imported into the country also makes it a very viable enterprise for consideration by local farmers.

There is no reliable and documented information on button mushroom production in Botswana. Prospective farmers need to be trained to be equipped with the technical skills and, thereafter, financially supported to take up button mushroom production in Botswana. Of note, button mushroom production is a biological process, therefore, different from crops such as cabbage, tomato and others. It is therefore, necessary to understand the biology of mushrooms to appreciate the basic steps in mushroom cultivation.

This production guide is prepared with the purpose to provide basic knowledge and techniques required for button mushroom cultivation. The guide will help to support trained prospective farmers, targeting small and medium scale farmers, with the required step by step process that help to sustain a successful mushroom farm.

These mushrooms grow on compost that comprises of plant-based material which provides nutrients to the mushroom. Therefore, good knowledge of compost preparation is very important for mushroom cultivation. In addition, knowledge of crop management, understanding environmental conditions (e.g. temperature and humidity) are also needed.

After going though the production guide, below are key points to learn.

KEY POINTS

You should know:
- The appropriate and available materials in Botswana required for preparing compost for button mushrooms;
- Making compost for button mushrooms;
- Pasteurizing the compost to promote growth of button mushrooms during cultivation;
- Identify and manage different environmental parameters during cultivation of button mushroom.

REQUIREMENTS TO START A BUTTON MUSHROOM ENTERPRISE

In order to start any business enterprise, it is important to ensure that a farmer has studied the market and is aware of its requirements. Button mushroom farming is different from tomato or cabbage production. Mushrooms are fungi and hence their requirements are specific, and it is essential to always maintain sterile conditions to reduce contamination. Basic requirement to start the mushroom business are the following:

- Land to build the production structure and the shed.
- Structure to produce the mushroom.
- Reliable and good source of spawn (mushroom seed).
- Good and readily available substrate for composting.
- Clean water supply.
- Electricity and Airconditioning or cooling unit.
- Market access.

A. LAND REQUIREMENTS

Mushroom production can be achieved on any land size. However, for small scale production, an area of two hundred and fifty square meters (250 sqm) is set as the minimum space for a viable commercial farm. The area is required to have all your consumables and equipment within reach. The most essential element is determined by the size of the production. Under ideal conditions one requires at least one production structure of about 30 sqm (6m length * 5m wide *2.5m high), a shaded structure of 50 sqm for storage of straw, firewood and drums required for sterilization. A mushroom project for small scale farming can be done at the backyard building or structures.

B. STRUCTURE FOR BUTTON MUSHROOM

Environmental conditions in Botswana do not favor button mushrooms and so a modified growing environment is required for a sustainable production system. The design of mushroom structures will depend on the financial status of the farmers. The design concept can be tailor made for each enterprise. Insulated growing rooms with cooling units are imported and installed on site. For small scale farmers, a low technology structure can be constructed using thatching grass, and treated poles. The low technology production house is modified by adding a cooling unit with temperature range of -5 to 25 °C and this is important in a mushroom production structure to maintain temperature and humidity within prescribed ranges to meet its requirements at different growth stages.

Fig 1. Low-cost mushroom production house and the proposed modification-cooling unit

Fig 2 . Mushroom house using thatching grass

Fig 3. Mushroom house from Cold storage panels and gum pole.

Fig 4. Shed used to store substrates and other materials

PLANNING FOR PRODUCTION

1. PLANNING

Spawn: The spawn is the seed of the mushroom and purchased from reputable producers/ distributers locally or import regionally/internationally. Spawn can be a source of contaminants therefore it is important to source from reputable companies. In South Africa, Sylvan Africa (Pty) Ltd, is licensed to distribute button mushroom spawn. Other companies include Myshrooms and Mushrush. Source spawn before starting the production and store at 25 °C.

Growing Materials: Purchase wheat straw, wheat bran, gypsum and store in a dry shaded area.

Labour requirements: The size of the production farm determines the amount of manual labour required.

Equipment: 200L drum, firewood, steaming cage, drum stand, growing bags, gloves (heavy duty and sterile gloves) and others.

Fig 5. 210L drum used for pasteurization.

Fig 6. Cage for steaming compost.

2. ALTERNATIVE STRUCTURES

Fig 7. House made of brick and corrugated iron.

Fig 8. Shelving made from steel frames.

Fig 9. Cooling unit in a modified production house.

STAGES OF PRODUCTION

STAGE 1 OF PRODUCTION

Compost can be purchased from reputable companies such as Monaghan, Agaris distribution center or other companies. For smalls scale farmers, it is not economically feasible to purchase compost due to high costs. Therefore, this represents an opportunity agriculture entrepreneurs to partake in the mushroom value chain and localize compost production using locally available inputs, as the retail price is high. For start-up button mushroom production, in-house production of compost is advised.

COMPOST FOR BUTTON MUSHROOM - INGREDIENTS AND FORMULATIONS

There are two recognized methods used to prepare compost and these are the long method and short method. The long method takes 28 days to complete compared to the short method which takes 19 days. The short method consists of two phases, Phase-I and Phase-II.

Regardless of the method used, ingredients required to prepare compost are as follows. The compost is prepared by using straws (wheat and millet are among top choices), manure (chicken manure widely used and available in Botswana), urea, gypsum.

The formulation of compost requires a carbohydrate material that is provided by various straws such as wheat and millet. Chicken manure provides nitrogen, and gypsum is used to balance the pH. Growers who choose to use the long composting methods should avoid chicken manure and opt for wheat bran to reduce disease incidence. Nitrogen content should be balanced using urea or any ammonium-based fertilizer. An example of a formulation is as follows:

Table 3. Formula For Composting And Associated Costs

Item	Amount	Cost (BWP)
Wheat straw	1000 kg	1600
Wheat bran	250 kg	600
Chicken manure	300 kg	225
Urea	18 kg	400
Gypsum	18 kg	400

[* 2024 prices, subject to change annually.]

HOW TO DETERMINE COMPOST QUALITY?

Good quality compost is key to high yield in mushroom cultivation. A farmer should be able to identify good quality compost, which is dark brown in colour, not greasy or sticky, distinct sweet aroma and no foul smell. Good compost is free from ammonia smell, has 65-67% moisture and pH 7.2-7.8. There should not be any visible growth of other microorganisms (except Actinomycetes that are beneficial to mushrooms) and/or insects.

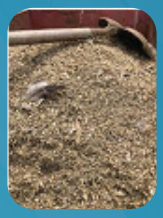
METHODS OF COMPOSITING

1. Long method of composting

This is the oldest method of composting that takes up to 30 days wherein compost is turned 7-8 times during preparation. First, the area is cleaned and disinfected with 2% formaldehyde. Water is sprinkled on straw until 75% of moisture is absorbed. All ingredients are added except gypsum. The mixture is piled 1.5m in height and width while the length depends on the amount of substrate. At day 25, disinfect the compost and place a clear plastic for two days before spawning.

STEPS OF LONG COMPOSTING

STEP 1



Clean area with formaldehyde then, spreak and sprinkle with water.

STEP 2

Prepare a heap

STEP 3

Turn the compost at day 6, 10 , 13

STEP 4

Add gypsum (lime) when turning at day 13. Then form pile and turn at day 16, '19, 22 and 25.

STEP 5

Spawn if no ammonia smell → Break open pile → Pile formation if there is ammonia smell

↓

Spray with 2% formaldehyde + 50g bavistin + 40l water

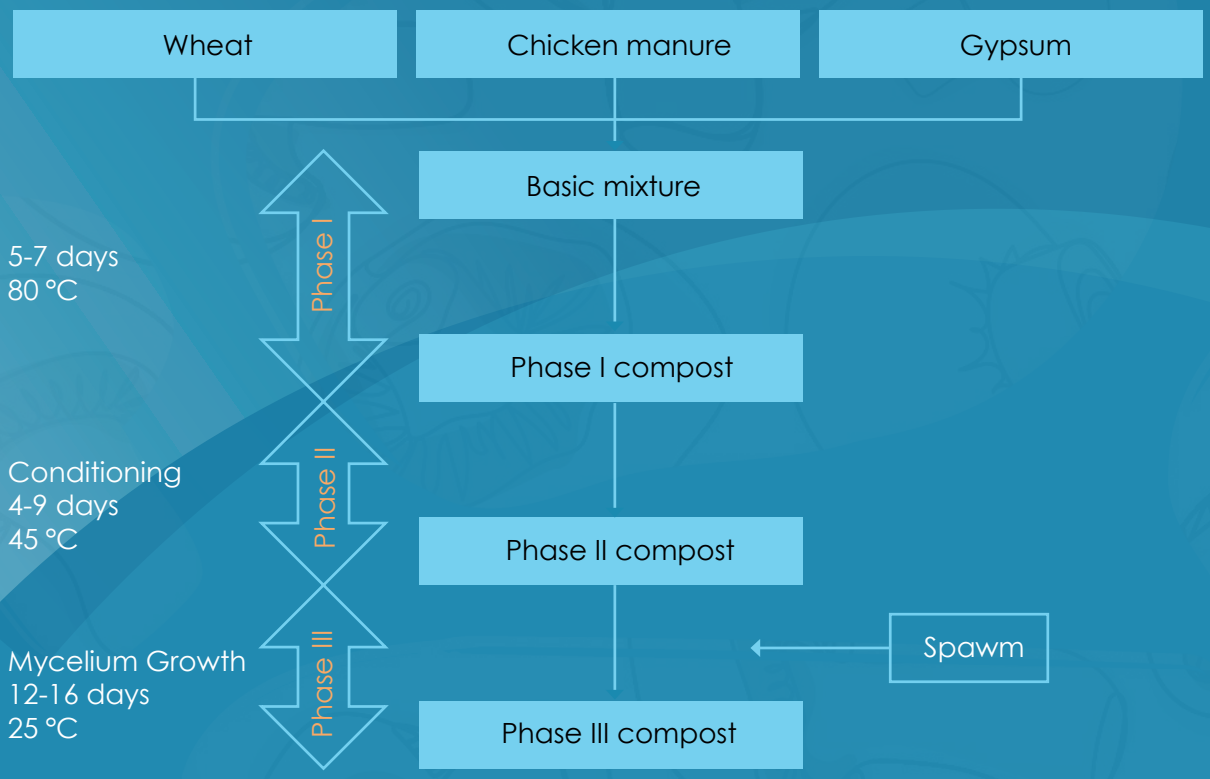
STEP 6

Fig 10.
At 28 days, cover with plastic for 2 days.

2. Short method of composting

This commonly used method starts with phase I: The mixing and wetting of ingredients until they absorb about 75% moisture, and are turned 2-4 times. Keep leached water by collecting it and reuse for wetting materials. The ingredients are either filled in a bunker or piled. Break open the stacked materials after 2 days, add water to the dry portions and stack materials again. Then the composting begins. At the start of composting, break the stack and add other raw materials i.e., urea. For aeration, compost is turned every 2 days while gypsum is added at 3rd or 4th turning. Phase I lasts for 10-12 days. After this, compost is pasteurized in phase-II, which lasts for up to 7-9 days.

STEPS OF SHORT COMPOSTING



2.1 PHASE I OF COMPOSTING

Fig 11. Step 1: Wetting and mixing the materials - wheat straw and bran, urea , gypsum.

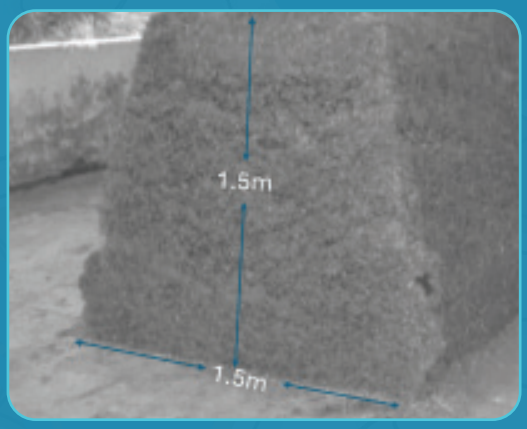


Fig 12. Step 2: Turn compost every 2 days and add gypsum at third turning. In all, give three to f our turnings.

2.2 PHASE II OF COMPOSITING (Pasteurization)

Fig 13. Phase II(Pasteruization) in a low technology tunnel. Use 45-52 °C for 24hr-48hrs then raise to 59°C and pasteruize for 46hrs.

Alternative method for phase II (pasteurization) of composting.

Fig 14. Use drum and wire cage to steam pasteurize compost . Use 45-52°C for 28hrs-48hrs then pasteurize to 59°C for4-6hrs.

How is compost after Phase-II?

- Dark brown in colour.
- Pleasant smell.
- Soft, straw breaks easily.
- Moisture around 64-66%.
- No liquid oozes when squeezed firmly
- Compost does not stick.
- Hands stay clean and dry.

STAGE 2 OF PRODUCTION

2.1 SPAWN RUN AND CASING

Fig 15. Spawn at 2-5% weight compost and place in bags for spawn running at 24°C for 12-15 days

Add layer of peat soil as casing material

TABLE 4. SPAWNING RATE AND ASSOCIATED COSTS

Weight of substrate	100 kg	250 kg	500 kg
Weight of spawn (kg) at 5% spawning rate	5	12.5	25
Cost of spawn (BWP) at 5% spawning rate	500	1250	2500
Shipping Costs (BWP)	1000.00	1500.00	2500.00

[* 2024 prices, subject to change annually.]

STAGE 3 OF PRODUCTION

3.1 Cropping And Harvesting

Fig 16. Fresh mushrooms packed as per market expectations.

Water the compost after casing to maintain (80-95%) moisture. Temperature is kept around 25°C for 7 days to allow the spawn to fully colonize the compost. Then lower temperature to 16-18°C to promote pinning. The pins will mature in 3-4 days when mushrooms are ready for harvesting. Each harvest is called a flush. After first flush, maintain similar conditions (temperature, moisture) to reach 3-5 flushes in about 4-6 weeks' time. Hand picking is the most recommended method to preserve the integrity of the mushroom.

MANAGEMENT OF PESTS AND DISEASES

The following are some of the diseases that affect mushrooms.

FUNGAL DISEASES

It is caused by Verticillium fungicola.
The most common symptoms of the disease include muddy brown, often sunken spots on the cap of the mushrooms and a greyish white moldy growth seen on pileus. Later stage mushroom becomes dry, and the initially infected one are not developed or remain small. Main sources of infection or inoculum include dust on floors of growing house, spread or water splashes on healthy mushroom and sciarid and phorid flies carry the inoculum over long distance. The microorganism is known to thrive in conditions such as favorable temperature of 28°C, poor ventilation and high humidity.

Fig. 17. Muddy brown spots on a mushroom infected with dry bubble disease.

The disease is controlled by picking and destroying infected mushroom to prevent spread, maintaining sanitary conditions in growth house, lowering the temperature to 14°C when disease is noticed, using clean equipment and controlling flies and mites. Adding salt around the infected mushroom has also been proven to be an effective control measure.

WET BUBBLE

Fig. 18. Wet bubble of button mushrooms.

It is caused by Mycogone perniciosa.
Common symptoms include malformed mushrooms with swollen stipes, reduced or deformed caps, undifferentiated tissue becomes necrotic and a wet, soft rot emit bad odor, an amber liquid appears on infected mushrooms, mushrooms become brown in color and bubbles may enlarge. The fungus is spread via airborne dust and contaminated casing.

Control the disease by sanitation in growing rooms, use benomyl at the rate of 0.95 g/m2 or carbendazim and thiabendazole at the rate of 0.62 g/m2 in casing.

COBWEB

Fig. 19 Cobweb diseases on mushroom

It is caused by Cladobotryum dendroides.
White silky growth grows over surface of casing soil and covers everything on its path. Infected mushrooms become soft before being engulfed by a ball of mycelia. The main source of infection is the casing soil. The disease can be common during prolonged high humidity.

Management of cobweb requires strict and regular surveillance. It is important to identify symptoms early, not only the web but also cap spotting. Spotty infections must be treated with a alcohol drenched paper towel before Covering infected areas with salt. Maintain hygiene during harvesting and watering. Use fungicides such as benzimidazole and chlorothalonil.

BACTERIAL SPOT /BROWN BLOTCH

It is caused by Pseudomonas tolaasii.
Symptoms include pale yellow spots on the surface of the piles later it turns to yellow and in severe cases mushrooms are radially streaked. Mushrooms often experience damage at postharvest. Sources of contamination may be soil or water. The disease thrives during high humidity and watery conditions.

Vector: Tryoglyphid mite
Lesions on tissue that are pale yellow initially, later become a golden yellow or rich chocolate brown. Discoloration is superficial (not more than 2 to 3 mm) and underlying tissue may appear to be water soaked and grey.

Blotches appear in early button stage, at any age – including postharvest. At favorable moisture conditions spots enlarge and coalesce, sometimes covering entire cap and the mushroom stems can also be blemished similarly. Spotting is observed at or near the edge of mushroom caps wherever caps remain wet for a period of 4 to 6 hours or longer after water has been applied.

Fig. 20 Brown spots on a mushroom with bacterial blotch disease

Sometimes casing and air-borne dust are primary source. The bacterial pathogen can be present in casing even after pasteurization. The occurrence of disease associated with the size of the bacterial population on the mushroom cap, rather than on the population in the casing, which explains why a prolonged wet period on the cap precedes disease occurrence. It can be spread by splash, tools, flies and nematodes. It must be noted that moisture content of less than 62 percent at spawning preconditions mushrooms to blotch infection.

The disease is controlled by sanitation, lowering humidity or watering with a 150-ppm chlorine solution (calcium hypochlorite products are used). If the mushroom stays wet, however, chlorine has little effect since the bacterial population reproduces at a rate that neutralizes the effect of the oxidizing agent.

GREEN MOULD

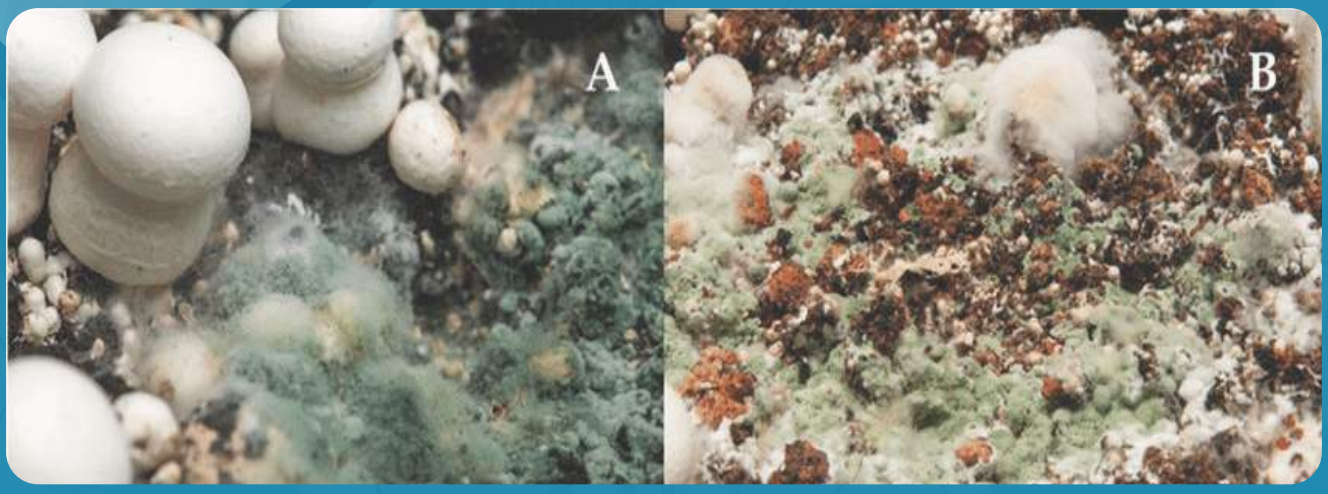


Figure 21. Green mould on mushroom (a) and on casing (b).

It is caused by Trichoderma koningii, T. viride or T.aggressivum f. sp. aggressivum. It produces dark green mould patches on casing spreading to lesions on stems. Some of the strategies that are introduced to control the disease include establishing and maintaining a sanitation and hygiene programme, especially targeting post cropping. Covering the spots with sodium hypochlorite solution, salt, lime or gypsum and lime mix. Good insect and mite control can help to prevent spread over a distance. Personnel movement patterns further reduce the spread of the disease.

Chlorothalonil may be added at casing or mixed into casing material 254 mL formulation per 100 m2 of production but it should be known that chlorothalonil is not effective against an established infection but lowering the infection.

POST HARVEST STORAGE

Mushrooms are highly perishable (short shelf life) so low temperatures (6-8°C) are required immediately after harvest.

ECONOMICS AND PROFITABILITY MEASURES

Mushroom cultivation in Botswana will be more suited in winter conditions given the low temperatures during this time. A summary of the costs in a small scale mushroom set up are detailed in Table 3 and 4.

Table 3. Required Fixed Costs For Button Mushroom Production Enterprise

Item	Unit	Price per Unit	Qty	Total Cost (BWP)
Straw soaking bins	350L	450	5	2,250.00
Galvanized steel Drums 210L	210L	300	5	1,500.00
Packaging Machine		3000	1	3,000.00
Temperature & humidity gauge		400	4	1,600.00
Building of 3 x Mushroom houses		40000	3	120,000.00
Air conditioner		12000	3	36,000.00
Shelter (50sqm)		25000	1	25,000.00
Plastic cutting machine		1000	1	1,000.00
Weighing scale		2500	2	5,000.00
Straw sterilizing Cage		500	5	2,500.00
		Sub-total		**197,850.00**
		Incidental Costs (10%)		**19,785.00**
		Net-Total		**217,635.00**

[* 2024 prices, subject to change annually.]

The fixed costs are based on using low technology and locally available building material, the price will increase as building is advanced to concrete block and metal shelving is used.

For profit projections, the profit projections are dependent on the size of the enterprise as well as the management practices used by the farmer. At best performance and under strict controlled conditions, production is up to 25kg per square meter. However, pessimistic yields given the low technology production system is based on 80% biological efficiency.

TABLE 4. PROJECTED BUTTON MUSHROOM INCOME STATEMENT BASED ON DIFFERENT BIOLOGICAL EFFICIENCY LEVEL FOR SINGLE PRODUCTION CYCLE

Gross income		Unit	Unit Price	Qty	1000 kg Substrate		
					50 % BE	70 % BE	80 % BE
Mushroom sales	Punnets	250g	25		45000	63000	90000
Total					**45000**	**63000**	**90000**
Production costs							
Variable costs							
	Mycelium / Spawn (Liter)	Bag	200	20	4000	4000	4000
	Transportation of Spawn	trip	1000	1	1000	1000	1000
	Permits				2000	2000	2000
	Wheat Straw	500KG	800	2	1600	1600	1600
	Wheat Bran x 4 (150kg)	600KG	150	4	600	600	600
	Lime x 4 (50kg)	600KG	150	4	400	400	400
	Urea (50kg)	50KG	400	1	400	400	400
	Plastic	1 ROLL	1000	1	1000	1000	1000
	Punnets (100)	Packet	100	21	2000	2000	2000
	Ethanol (99%)	5L	2000	2	4000	4000	4000
	Sterile gloves	Box	250	10	2500	2500	2500
	Utility bills (Electricity + water)				2000	2000	2000
	Sub-total				**21500**		
Labour costs	Casual workers	wage	1800	2	3600	3600	3600

	Manager wage		3500	1	3500	3500	3500
	Sub-total					**7100**	
Marketing	Airtime	Monthly	300	2	600	600	600
	Sub-total						
Transport	Delivery	Trip	300	8	2400	2400	2400
	Sub-total						
	TOTAL EXPENSES				31600	31600	31600
	NET INCOME				**13400**	**31400**	**58400**

[* 2024 prices, subject to change annually.]

The assumption for the calculated net income is based on a single production cycle which takes 14 to 15 weeks to complete in a single growing room. The annual net income is bound to change if the production is calculated for the whole year. In a year, there will be between 3 and 4 production cycles based on the quality of compost used. The quality of compost affects profitability.

TABLE 7. PRODUCTION CYCLE FOR BUTTON MUSHROOMS

Activity	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	WK14	WK15	WK16	WK17	WK18	WK19	WK20	WK21
Substrate Preparation																					
Composting																					
Spawn Running																					
Casing																					
Mushroom fruiting & Harvesting																					
Room sterilisation																					
Substrate Preparation																					
Composting																					
Spawn Running																					
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LEA

LOCAL ENTERPRISE AUTHORITY

Tel: (267) 3644000
Fax: (267) 3644001
Whatsapp: 3973022
Email: botsalea@lea.co.bw
Website: lea.co.bw

Toll Free: 0800 155 155
Head Office
Fairscape Precint Lot 70667 Building 1,
Ground Floor Unit 2A
Private Bag 191, Gaborone, Botswana

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