Mushrooms

Scientific Name:

1. *Agaricus spp.* (button mushrooms);
2. *Pleurotus spp.* (oyster mushrooms)

Order / Family:
Agaricaceae (*Agaricus spp.*); Pleurotaceae (*Pleurotus spp.*)

Local Names:
Swahili: Uyoga; Luhya: Obwoba; Luo: Obwolo; Kikamba: Makunu; Kikuyu: Makunu; Kalenjin: Bobat

General Information

Cultivated mushrooms are edible fungi that grow on decaying organic matter, known as a substrate. Unlike vegetables, they do not rely on sunlight to grow. Mushrooms start as very small spores (reproductive structures like very, very tiny seeds in fungi). The spores will grow in the substrate to produce a network of fine white filaments called mycelium (portion of the mushroom that grows underground). From the mycelium, the mushroom fruit is produced. This is the part that is harvested.

Benefits

Mushrooms have a high nutritional value and are high in protein.
They are also a good source of vitamins (B-complex and C), essential amino acids, and carbohydrates but are low in fat and fibre and contain no starch.
Minerals present include phosphorus, potassium, iron, calcium, zinc and copper.
They are an ideal diet for diabetics and weight-watchers.
Some species are also grown for their medicinal value.

Mushrooms are a valuable source of food and their cultivation can be a viable small-scale business, but investing in a mushroom growing scheme can be risky so a feasibility study looking at potential markets and supply chains should be done before starting. A general understanding of mushroom growing should be obtained through training or literature to ensure the best chance of success. Some expert assistance will help at this stage. Jomo Kenyatta University of Agriculture and Technology Enterprises (JKUATES) has highly skilled consultants in this field offering innovative trainings of mushrooms to interested parties.

As well as individual small-scale production, set up options include cooperatives and community groups that can collaborate in set-up costs, production costs, harvesting and marketing. It does not help to work in isolation, but in joint ventures with regional agro-industries and universities as they

can assist with linking to market outlets and training. The most popular mushroom species grown in Kenya are button (*Agaricus* spp.) and oyster (*Pleurotus* spp.). Button mushrooms are widely cultivated by large-scale farmers, as their production requires high input technology. Small-scale farmers using simple production techniques mostly grow oyster mushrooms.

Before starting to grow mushrooms, farmers should consider the following:

1) potential markets and supply chains
2) source(s) of high quality spawn ('seeds' of mushrooms)
3) availability of substrate (material on which mushrooms grow)
4) availability of supplements (additional nutrients to the substrate)
5) production plan to ensure continuous production

Markets and marketing

When considering producing mushrooms as a business, check on the following:
1) Type and amount in demand by market outlets
2) Their price and availability
3) Current distributors and possibility of business relationship
4) Possibility of value addition

Small-scale farmers are therefore, advised to identify where they can sell their mushrooms, especially to the nearest markets before starting production.

Production plan

Farmers must plan their production in such a way that they produce only the amount they are able to sell. They can divide their production units into four sections such that each section has mushrooms at different growth stages at any one time. This way they will maintain a consistent supply to the market.

Spawn in a bottle

Spawn

It is a planting material equivalent of farmers' seed for starting mushroom cultures. It is made from mycelia (plural of mycelium) of mushroom grown on a carrier such as grains and is produced in specialized laboratories under sterile conditions. The amount of spawn needed is equal to 4-6% of the wet weight of the substrate. For example if the wet weight of the substrate is 50 kg, 2-3 kg of spawn is required. One kg of spawn may cost between Kenya shillings 600 and 800.

In Kenya, there are a number of institutions such as JKUAT producing high quality spawn. Farmers who need spawn or training can contact the university at the following address: JKUAT Enterprises Ltd., P.O. Box 62000-00200, Nairobi. Mobile phone: 0724256696.

Wheat straw

Substrate

Substrate is an organic-based material on which mushrooms grow. In addition, a good substrate should be rich in nutrients, have good aeration and water holding capacity. Substrates commonly used in mushroom production include agricultural by-products such as cereal straws (wheat, barley, and rice, maize), cotton waste, maize cobs, coffee husks and pulp, sawdust, sugar bagasse, water hyacinth among others. However, cereal straws, particularly wheat straw, are usually the best because they are rich in nutrients that mushrooms require and they facilitate quick colonization (the formation of a white mass of mushroom mycelium) of the substrate.

Gypsum is a useful ingredient to be added to the substrate as it provides calcium to the growing mushrooms, regulates the acidity level of the substrate, counters potassium, magnesium and phosphorus concentration and increases water holding capacity thus decreasing the risk of over wetting. It also improves the physical structure of the substrate. Lime may also be added to the substrate to adjust its pH (level of acidity)

It should be noted that different species of mushrooms will require different substrate mixes. The substrate must not be rotten, mouldy and should be kept dry while in storage.

Supplements

These are materials added on the final mix of substrates to increase nitrogen content in order to improve the yields. Commonly used supplements include urea, bran, cotton seed cake, sunflower seed cake, molasses, broiler chicken manure and horse manure among others. However, it should be noted that heavy supplementation might increase the risk of contamination by other microorganisms, which are likely to benefit from extra nutrients added to the substrate.

Mushroom house

Mushroom house should not be sited near dumping sites and livestock pens to reduce the risk of insect infestation and diseases. It should preferably be under shade. The house can be made from locally available materials that can maintain cool temperatures and high humidity such as clay or bricks. In a small scale farmer scenario, a grass thatched mud walled house is the most ideal. The house should have air vents or small windows on the upper walls for ventilation and required light during fruiting.

The vents and door should have insect screens and be closed. If the temperature inside the house is high, water can be sprayed on the floor using a knapsack sprayer with fine nozzles and vents and door opened at night. Wooden shelves for holding bags or wooden racks for hanging spawned substrate tubes should be constructed at the height of about 1.5 m from the ground and 1 m apart for ease of working in the growing house.

Overview on production of mushrooms

A detailed step by step procedure with colored photos on cultivation of button and oyster mushrooms is given “Guide to growing mushrooms" by JKUAT. Farmers intending to start mushroom production as a business are strongly advised to undertake a hands-on training on growing mushrooms. JKUAT conducts short training courses on mushroom production.

Phases of cultivation of button and oyster mushrooms

Phase	Time span and temperature	Remarks
Substrate preparation	6-8 hours for soaking shredded straw in water for oyster. Pre-wetting of wheat straw for button is done for 3 days	Selection of substrate. Cereal straws are preferred. Wheat straw is ideal for button. In case of oyster, it involves shredding, soaking in water to 70% moisture content (1), draining excess water, adding supplements plus lime and packing into polybags.
Composting	18-20 days	Oyster does not require composted substrate. Only applicable to button. Involves pre-wetting of wheat straw to 70% moisture content, adding supplements plus lime and gypsum. Good compost is dark brown, 70% moisture content and pH 8.0 - 8.5 (2)
Pasteurization and conditioning	4-6 hours of steam heating at 60degC for oyster and cool polybags to 20-25degC. For button steam for 8 hours and lower the heat for 4-5 days at 45-50degC then cool to 22-25degC	Steam heating of oyster polybags is done in water drums but it can also be done in hot water at boiling point for 1 hour. Button steaming is done in special chambers (tunnels). Conditioning is to remove ammonia gas which is poisonous for button. Cooling is in preparation for spawning. The moisture content of the substrate then should be 67-70%
Spawning and incubation	5-10 days incubation for oyster; 15 days for button at 23-25degC	Applying spawn to substrate in polybags. The growing room should be kept humid (RH 65-95%) (3) with dim lighting just sufficient to read a newspaper
Casing	Sterilize casing soil for 4 hours at 60degC. Casing run (4) is 14-15 days at 25degC	This is not applicable in oyster production. Casing is applying a thin layer of red top soil added with murram and lime on top of fully colonized substrate. Casing soil should be kept wet but not waterlogged. Substrate turns white to

		grayish due to the colour of mycelium. It is now ready for fruiting.
Pinning	Oyster 5-10 days in the growing house at 23-25degC. Button 7-10 days but the growing house temperature will depend on variety (5)	Pinning is when mycelia start fruiting (formation of very young mushroom known as 'pin heads'). It takes 3-4 days for pin heads to develop into mature mushrooms. RH required is 85-95%.
Harvesting	Oyster about 30 days, button 30-40 days from spawning to harvesting	Oyster harvesting is done when the mushroom ear is 7.5-10 cm in diameter, turgid and bright in colour. Button is picked at the young stage before opening. Repeated over 7-10 day cycles

(1) When the substrate is squeezed between the fingers it should give 2 to 3 drops of water. If it gives more drops, continue draining and with fewer drops add more water.
(2) pH is a measure of acidity. A pH value of 7 is neutral, lower than 7 is acidic and above 7 is alkaline. It can be determined using a pH meter. pH meters are readily available in shops selling laboratory equipment for schools in urban areas of Kenya.
(3) Relative humidity (RH) is the percentage of moisture in the air compared to the maximal amount that the air can hold at that temperature and pressure. It can be monitored by using a hydrometer which can be bought in shops selling laboratory equipment. If the RH is low, spray clean water on the floor or place pots with water in the room. If the RH is above the required, open windows or vents of the room.
(4) Casing run is the period in which the mycelia is left to grow on the casing soil.
(5) There are varieties grown: white mushroom or 'champignon') (*Agaricus bisporus*) and tropical mushroom (*Agaricus bitorquis*). During pinning the temperature in the growing house should be reduced from 25 to 20-22degC for tropical mushroom, and for white mushroom to 12-18degC.

Yield

An average of 33 kg of fresh button mushrooms per square metre of substrate can be obtained. In case of oyster mushrooms yield depends on the type of substrate used. For example wheat straw would convert at 75 to 100% (75-100 kg fresh mushrooms are expected from 75-100 kg of dried wheat straw).

Post-harvest handling

Mushrooms are highly perishable and if possible should be sold the same day of harvest. Under cool conditions their shelf-life is 1-3 days. The shelf-life can be extended to up to 7 days under refrigeration at 10degC. Surplus can be preserved by drying, canning, pickling and grinding dry mushroom into powder for soups and on value addition purposes.