Production of Mushroom

Modern structure for mushroom production

The front view of a modern mushroom production shed.

Substrate sterilization

1. Weigh the substrate when still dry; spread it on a table or polythene sheet which is spread on the floor. Take the following and add to the substrate in the following ratios: 1% of lime or gypsum of the dry weight of the substrate for control of Ph, aeration and acceleration of colonization of the substrate , 5% supplement – cotton seed cake or sunflower seed cake or soy bean meal cake of dry substrate to improve the protein and mineral nutrients to the substrate 5% of molasses to improve the nutritional value of the substrate in terms of carbohydrates. Put water in a basin and mix all the above thoroughly to form a solution.Sprinkle the solution on the substrate and mix it thoroughly. Add in more clean water till the whole substrate is wet. Apply the squeeze test. Only a few water drops should come out of substrate, and then know it's ready for use. Stack the substrate in empty polythene -bags (preferably 12" x 18" of gauge 125 – 150 either black or clear and close the top tightly using a string - sisal twine.
2. Put a wooden rack with a height of around twenty 6 inches at the bottom of a drum,
3. Fill water in the drum up to the height of the rack,
4. Pack the filled bags inside the drum placing them on the rack. Avoid the tubes from touching the water for we need the substrate to sterilize by use of steam
5. Close the drum using a lockable lid and punch a small hole at the top to allow the excess steam to escape via it. Boil the substrate until you start seeing steam coming out of hole. Start counting 45-60 minutes from the time you see the steam. Reduce the amount of heat being supplied to the drum for 15minutes. Let it cool before you remove the sterilized materials. Caution – Let the drum cool down completely before you open the lid to avoid being burned by the steam.
6. Remove them from the drum and let them cool down overnight. They should be stored in sterile environment to avoid contamination.

The substrate is being mixed with broiler starter, water, molasses and lime

The substrate being bagged for sterilization

Spawning

Select your working area which should not have dark alleys that are good breeding grounds for bacteria and fungi. The area should have controlled air/current flow.
Take the substrate, spread it on a sterilized table or polythene sheet by use of methylated spirit or surgical spirit or jik and inoculate it with the spawn. Spawn application should be 2 kgs of

spawn to l5 kg of dry weight of substrate. There after, the inoculated substrate is then compacted in the polythene tube and close the top by use of a sisal string.

Perforate holes round the tube. The holes should be 2 inches in diameter with a distance of 4 inches from one another. Make sure there are no air pockets in the poly bag. After 14 days, increase the humidity in the house by pouring clean water on the flour for it to start vaporizing to humidify the room. Do not spray water in the room for it will contaminate it. This can be done 3-4 times per week depending on the temperatures.

After 6-7 days the pin-heads will start to appear, reduce the humidity. Within 2 -4 days' mushrooms will be ready for harvesting. Ensure to harvest before they are fully grown. Continue pouring water on the flour and the cycle will repeat itself 4-5 times flushes. This will also depend on the amount of nutrients in the substrate.

The stalked substrate bags are placed in the drum which is heated for a period of 45 minutes.

The substrate after spawning and stalked in tubes ready for hanging in the shed

Tubes having been hanged in the shed to start colonization

The tubes have fully colonized and mushrooms are about to sprout. The system is now favoured by all mushrooms farmers for it has reduced the cost of labour in terms of spraying water and generally on crop management. Production is nearly 100%.

A farmer admiring his mushrooms in his shed ready for harvesting.

Mrs Khabega a mushroom farmer in Nakuru town admiring her good Quality mushrooms after harvesting ready for the market.

Mrs Khabega's fresh oyster mushrooms packaged ready for market delivery

Trouble Shooting

"Prevention is better than solving the problem"

PROBLEM	CAUSE	SOLUTION
Mycelium fails to	Improper initiation strategy.	[illegible]
	Chlorinated or contaminated water	Use activated charcoal water filters to eliminate chemical contaminants or any other ways of simple or appropriate technology.
	Bad substrate.	[illegible]
	Bad pasteurization	Check method of pasteurization. Release all air and make sure there is continuous steam before starting pasteurization for a period of 1 hour.
	Substrate in the bag is too hot when inoculation	Make sure that the substrate bag is not too hot before inoculation.
	Bad strain or spawn	Obtain younger strain of known vitality & history.
	Spawn contaminated	Pasteurize and inoculate again with

		good spawn.
	Forgot to inoculate the bag.	Make sure to inoculate.
Poor spread of mycelium, bad smell, spots and mites.	Good pasteurize but must decrease the temperature in the pasteurization chamber. Pasteurization was too quick and/or the chamber door was opened too quickly.	Slowly decrease the temperatures in the chamber. Do not open the cover of the chamber too quickly. Check that the cotton plug is tightly closed.
	Inoculation process	Inoculate in hygiene conditions; clean and with no air movement.
	Too high density in the incubation area, not enough ventilation to decrease.	Spread the bag and make more air ventilation in the incubation area. Check temperature and control surroundings to.
	Accumulated temperature.	Maintain 25-35 degrees Celsius.
	Too high carbon dioxide	Not more than 5% carbon dioxide. Check ventilation.
	Hygiene of incubation house	Improve hygiene in the incubation house.
	Mycelium develops in patches. Substrate is not evenly prepared and sore parts have more nutrient than others	Mix well in substrate.
	Bacteria, other fungi contamination.	Check the process causing contamination. Separate contaminated bags as soon as possible. Remix substrate separately. Remake substrate bags and pasteurize for a longer time. Follow process.

	Mite contamination.	Immediately separate contaminated bags and pasteurize again. Continue the normal process.
Mycelium grows but fails to produce mushrooms.	Substrate formula is not suitable.	Adjust formula; check PH; sawdust ; additives etc.
	Mites, mould, virus, bacteria and insects.	Check pasteurization process, inoculation, other process, and mushroom house management for hygiene.
	Inhibited by environment toxins	Remove source of toxins.
	Bad strains or spawn	Acquire new strains.
Mushrooms form, but abort or delay mushrooming.	Primordia and growth condition of fruiting body are not good enough	Check temperature and humidity. Open or close doors and windows to adjust accordingly.
	There is contamination such as mould, bacteria, insects, worms and mites	Check hygiene, adjust environment of light. Temperature, humidity and ventilation. In more severe cases, use half a teaspoon of sulphur in 3.5 litres of water. Mist the bags and the surface of the mushrooms. Remove contaminated bags from mushroom house and recycle.
	Chemical contamination from solvents, gas, chlorine etc	Remove toxins.
	Bad strain	Acquire a new strain or find a new supplier.
Mushrooms form, but stems are long and caps	Inadequate light	Increase or adjust light to correct wavelength.

underdeveloped		
	Excessive carbon dioxide	Increase air exchange, open doors or windows and close at correct time.
Massive numbers of mushrooms form, few develop.	Too long time incubation	Shorten the period for the formation of primordia
	Lack of oxygen, inadequate light	Increase air ventilation and open more windows or doors to receive more light.
	Inadequate substrate nutrition or low quality.	Reformulate or check raw materials.
	Low rate mycelium growth	Use the high rate spawn or adjust good conditions for rate of growth.
	Poor strain	Obtain better strain.
Mushrooms are deformed, decay and die	Disturbed by germs or competing micro organisms	Adjust mushroom house t favour mushrooms and not germs and competitors.
	Dirty surface of substrate bags	Clean the surface of substrate
	Not enough air ventilation, too high humidity.	Increase air circulation. Reduce humidity to the prescribed levels. Surface water must evaporate from mushrooms several time per day. Check watering. If there is water in bags. Pierce bags and drain water.
	Bad strain.	Acquire better strain.
	Use of chemicals during this period.	Never use chemicals during the fruiting stage

Mushrooms fail to fruit	Inadequate substrate	Reformulate
	Competitors	Check hygiene, adjust light , temperature, humidity air and ventilation
	Poor management growing house	Improve management
	Bad strain.	Acquire new strain.
Mushrooms small sized.	Too many mushrooms coming out at the same time.	Reduce size of opening(s).
	Lack of nutrients in substrate.	Review quality of substrate.
	Change of weather.	Be aware of wide range of changes in temperature.
	Spawn unhealthy.	Check origin of spawn.
Pests and insects	Natural occurrence, humid climate.	Place lemongrass plants around mushroom house. Spread lime on shelves, on poles and ground in the mushroom house. Clean (and maintain clean) the mushroom house properly.
	Mushroom waste lying around mushroom house.	Try to use the waste as fertilizer or recycle.
	Ants	Mix detergent with water. Do not put water on mushroom. Move pots on which mushroom are placed.
Mushrooms are light in weight	Shortage of water.	Check humidity of mushroom

Mushroom quickly spoil	Mushrooms too mature when harvested.	Harvest when younger.
	Mushrooms too warm before packaging	Chill mushrooms before placing in marketing containers.
	Mushrooms too wet when harvested.	Reduce humidity several hours before harvesting.
	Mushrooms stored beyond shelf life.	Sell mushrooms faster.
Rotting sport on mushroom fruiting body because of bacteria during flush.	Bacteria (Pseudomonas tolaasil, Pseudomonas fluorescens) on oyster mushroom.	Control humidity in the mushroom house and maintain 80-85%. Give enough time for water to evaporate from mushroom surfaces before further watering. For sever cases, use 113 grams chlorine mixed in 45 litres of water or 4 ounces of chlorine per gallon of water.

TRUE FUNGAL DISEASES:

Dry bubble caused by *Verticillium fungicola*. It causes a severe loss of yield. It is characteristic of cinnamon brown spot on the mushroom fruit cap as the disease progresses the mushrooms become deformed with swollen, curved stipes and the cups develop asymmetrically. Ben late is the fungicide for control.
Mycogyne sp. This is a more recently introduced fungus with greyish mycelia, which grow and stifles the mushroom fruit. If it attacks before the fruits are formed then it causes failure in expansion of the pinheads. Control is by observation of hygienic measures. Affected trays should be removed out of the growing room and the material burnt.

Bacterial Diseases:

Bacterial Blotch, *Pseudomonas tolaasi*. It starts as yellow spots and gradually turns chocolate brown on the fruit. The mushroom cup feels slimy. The mushroom cup feels slimy. The whole cap may turn brown. For control, lower the humidity; do not leave water droplets on the cap. Use chlorinated water.

Virus:

Die back disease, results in the total loss of the crop. It displays a number of symptoms, patches of uncolonized casing. The mycelia die back. The cup and stripe have a drumstick. The stripes may be watery split and rotten. The cups open and flatten too early. Should this disease be noticed then the room must be steamed for twelve hours. Mushroom mycelia containing the virus should be removed and destroyed.

Mushroom competitors and diseases

TrichocieFma causing 30% fose
-Bacteria
-Competitor mushrooms
-Viruses
-Carbon dioxide accumulation
-Light deficiency and pesticide effect
-Trichoderma to be controlled by:-
-Pasteurisation of substrate
- Spore filters in inoculation rooms
-Use of other THcafs in substrate e.g. pfochorus, vmctozofin orbenomfyat 20-50mls for 5 litres of water**.**

Pest
These are sciarids and phorids which are attracted by mycelium scent,

Control

Use wire mesh in windows
-Yellow plastic for monitoring
-Sticky traps
-Pesticides e.g. Malathion, diltaethric
-Dichlorus and diflubenzuron

Termites
Use oil on timber works, drenching line around the housing and even gladiator, given our Geographical tropical location on the equator a suitable Housing is once of mud walls and a grass thatched roof. The current research has shown that the use of iron sheets improves the humidity of the shed provided the temperatures do not go beyond 32 degrees Celsius.

The inside is entirely cushioned with a PVC lining to assist in retaining moisture/humidity for longer periods. Light is a stimulus for growth and therefore assists Primordial development.

Note
That during the period of incubation and growth, you will notice the following:

1. Materials in the tube developing moulds – green, pink or black. With the green mould you take hydrogen peroxide and inject it direct using a syringe with a needle to the affected areas without diluting it. If it persists discard the tubes. With the other moulds do not apply hydrogen peroxide but instead discard all the affected tubes by burring them dip in the soil.
2. The mushrooms will be turning yellow in colour and drying from the edges. This shows that there is no enough water in the tube. You therefore need to add at list 2 litres of sterilized water from the top of the tube by use of a used water plastic bottles.

3. Mushrooms will start reducing in size. This is as a result of low nutrients in the growing materials. You need to add to every tube 250 gms of molasses and 250 grammes of broiler starter or cakes of soya beans or sunflower or cotton which you have to mix with water and sterilize for 1 hour to avoid contamination. Use a 1 litre bottle to pour the solution into the tube from the top.

MUSHROOM PRODUCTION COSTING PER CENTRE FOR THE 1ST YEAR.

	1st production			2nd production			3rd production			4th production		
Capital Investment	Quantity	Unit price Kshs	Total Kshs	Quantity	Unit price	Total	Quantity	Unit price	Total	Quantity	Unit price	Total
hand spray can	1 pc	300	300	-	-	-	-	-	-	-	-	-
driers	2pcs	7,500	15,000	-	-	-	-	-	-	-	-	-
shed	1hse	61,000	61,000	-	-	-	-	-	-	-	-	-
weighing scale	1pc	2,500	2,500	-	-	-	-	-	-	-	-	-
drums with lid	2pcs	2,000	4,000	-	-	-	-	-	-	-	-	-
basin	1pc	100	100	-	-	-	-	-	-		-	-
table spoon	1pc	10	10	-	-	-	-	-	-	-	-	-
hand gloves	6pcs	100	600	-	-	-	-	-	-	-	-	-
Masks	6pcs	40	240	-	-	-	-	-	-	-	-	-
gum boots	3pcs	800	2,400	-	-	-	-	-	-	-	-	-
caps	3pcs	100	300	-	-	-	-	-	-	-	-	-
dust coats	6pcs	1,200	7,200	-	-	-	-	-	-	-	-	-
water jug	1pcs	50	50	-	-	-	-	-	-	-	-	-
water pails	5pcs	100	500	-	-	-	-	-	-	-	-	-
mixing table	1pcs	2,500	2,500	-	-	-	-	-	-	-	-	-
Sub total			**96,700**	-	-	-	-	-	-	-	-	-
Operational costs		-	-	-	-	-	-	-	-	-	-	-
spawn	300kgs	400	120,000	300kgs	400	120,000	300kgs	400	120,000	300kgs	400	120,000
substrate	1lorries	10,000	10,000	1lorries	10,000	10,000	1lorries	10,000	10,000	1lorries	10,000	10,000
spirit	20litres	150	3,000	20litres	150	3,000	20litres	150	3,000	20litres	150	3,000
Broiler starter	2 bags	3,600	7,200	2 bags	3,600	7,200	2 bags	3,600	7,200	2 bags	3,600	7,200
molasses	2 Jeri cans	700	1,400	2Jericans	700	1,400	2 Jeri cans	700	1,400	2 Jeri cans	700	1,400
Polythene bags	3 pkts	500	1,500	3 pkts	500	1,500	3 pkts	500	1,500	3 pkts	500	1,500
polythene rolls	2rolls	3,500	7,000	2rolls	3,500	7,000	2rolls	3,500	7,000	2rolls	3,500	7,000
lime	1pkt	650	500	1pkt	650	500	1pkt	650	500	1pkt	650	500
water	1season	3,000	3,000	1season	3,000	3,000	1season	3,000	3,000	1season	3,000	3,000
sisal twine	2pcs	200	400	2pcs	200	400	2pcs	200	400	2pcs	200	400
fuel	1season	3,000	2,000	1season	3,000	2,000	1season	3,000	2,000	1season	3,000	2,000

Labour 3 people	3months	3,000	27,000	3months	3,000	27,000	3months	3,000	27,000	3months	3,000	27,000
Sub-total	-	-	**183,000**	-	-	**183,000**	-	-	**183,000**	-	-	**183,000**
Post harvest cost	-	-	-	-	-	-	-	-	-	-	-	-
packaging materials	3,000kgs	5	15,000	3,000kgs	5	15,000	3,000kgs	5	15,000	3,000kgs	5	15,000
transport to mkt	3,000kgs	5	15,000	3,000kgs	5	15,000	3,000kgs	5	15,000	3,000kgs	5	15,000
Sub-total	-	-	**30,000**	-	-	**30,000**	-	-	**30,000**	-	-	**30,000**
Total	-	-	**309,700**	-	-	**213,000**	-	-	**213,000**	-	-	**213,000**
Add 2% misc. costs			6,194	-	-	4,260		-	-		-	-
Total project cost	-	-	-	-		**217,260**	-		**217,260**	-		**217,260**
Expected yield	-	-	**3,000kgs**	-	-	**3,000kgs**	-	-	**3,000kgs**	-	-	**3,000kgs**
Less 2 % spoilages	-	-	**60kgs**	-	-	**60kgs**	-	-	**60kgs**	-	-	**60kgs**
Saleable yield	-	-	**2,940kgs**	-	-	**2,940kgs**	-	-	**2,940kgs**	-	-	**2,940kgs**
Production cost / kg	-	-	107.50	-	-	73.90	-	-	73.90	-	-	73.90
Sales price /kg	-	-	200.00	-	-	200	-	-	200	-	-	200
Gross margin	-	-	92.50	-	-	126.10	-	-	126.10	-	-	126.10
Expected income	2,940kgs	200	**588,000**	2,940kgs	200	**588,000**	2,940kgs	200	**588,000**	-	-	**588,000**
Gross profit	-	-	**270,300**	-	-	**370,740.00**	-	-	**370,740.00**	-	-	**370,740.00**