Knysna Municipal Community Mushroom Cultivation Project

Knysna community empowerment Project – producing food from waste.

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Funguys Gourmet cc. (Co.Reg.2008/125793/23)
DA Reynders and L T Reynders

Foreword

It is my intention with this document to outline a low budget formula, for the production of Oyster Mushrooms from Waste Barley Grain, Waste Paper and Grasses. The mushroom grow facility outlined in this paper is designed to be environmentally friendly, energy efficient and sustainable.

The Project is outlined in stages:

- Phase 1 will deal with Planning, Site Location and Construction of the Grow Facility.
- Phase 2 will deal with Costing
- Phase 3 will deal with Production of Mushrooms.
- Phase 4 will deal with Distribution and Marketing.
- Phase 5 will deal with Expansion and Progression.

Phase 1 - Planning, Site Location and Construction of the Grow Facility

Planning:

Planning the Project is by far the most time consuming activity in the process, but by taking care in weighing up all the options, the pros and the cons, the scope and intention we hope for decisive and consistent results. Planning for the economical tides that we locally and internationally may experience over the next couple of years as well as planning ahead for energy saving and efficiency is of utmost importance. Planning your project to be Green will have positive effects on your local economy. Planning ahead where you will find your substrates, what containers you will use to grow your mushrooms in and what waste products you yourself will produce is all part of this planning phase.

Scope:

1) What type of mushroom will grow well naturally in our environment and may very well be part of our local ecosystem?
2) Can I produce this mushroom through the year?
3) What does the mushroom need to thrive?
4) Planning the budget.
5) Consider financial increases of production cost.
6) Consider increases in energy charges.
7) Consider water usage and saving.
8) Consider what waste material you will produce and how you could recycle your own waste in a secondary productive process.
9) Negotiating with local businesses to supply you with substrate materials e.g. some types of garden refuse, waste barley grain from the local brewery, municipal grass clippings and paper from the paper recycling depot.
10) Negotiating with some local businesses or local government to sponsor or donate to the ongoing project e.g. shipping containers.
11) Consider the scope of expanding the project.
12) Planning a training manual for all staff.
13) Health and safety procedures.
14) Pest control.

Site Location:

Ideally you would like a site in the mountains with a crystal water stream flowing past your grow facility. In our world today this is becoming further and further away a possibility, so we chose to look at what we have.

Scope:

1) We need access to clean de-chlorinated water;
2) Easy access to the substrates that will be used;
3) Relatively clean air – low contamination levels from external sources;
4) North facing roof structure for solar equipment;
5) Easy access to market your product locally;
6) Accessible to Workforce;
7) Access to space outdoors for composting and Vermicast production (Secondary process - mushroom production);
8) Access to Cleaning facilities, toilets, change room for staff;
9) Access to Clean – SABS049 Standard – Packing facility;
10) Accessibility of existing rain water tanks will be beneficial;

Construction of the Grow facility:

There is a large sum of work to consider as well as intense planning before building your mushroom grow-facility. As an example I will consider using an empty factory space in the Knysna Industrial area and that the entire grow facility will fit within this factory space. Three main Zones must be created within this factory. Zone 1 is a public space, for administration, reception, deliveries etc. Zone 2 is separated from Zone 1 and will be used for cleaning, showering, have toilets and a changing room. Zone 3 is separated from Zone 2 and will house the mushroom factory. The following section will focus on Zone 3.

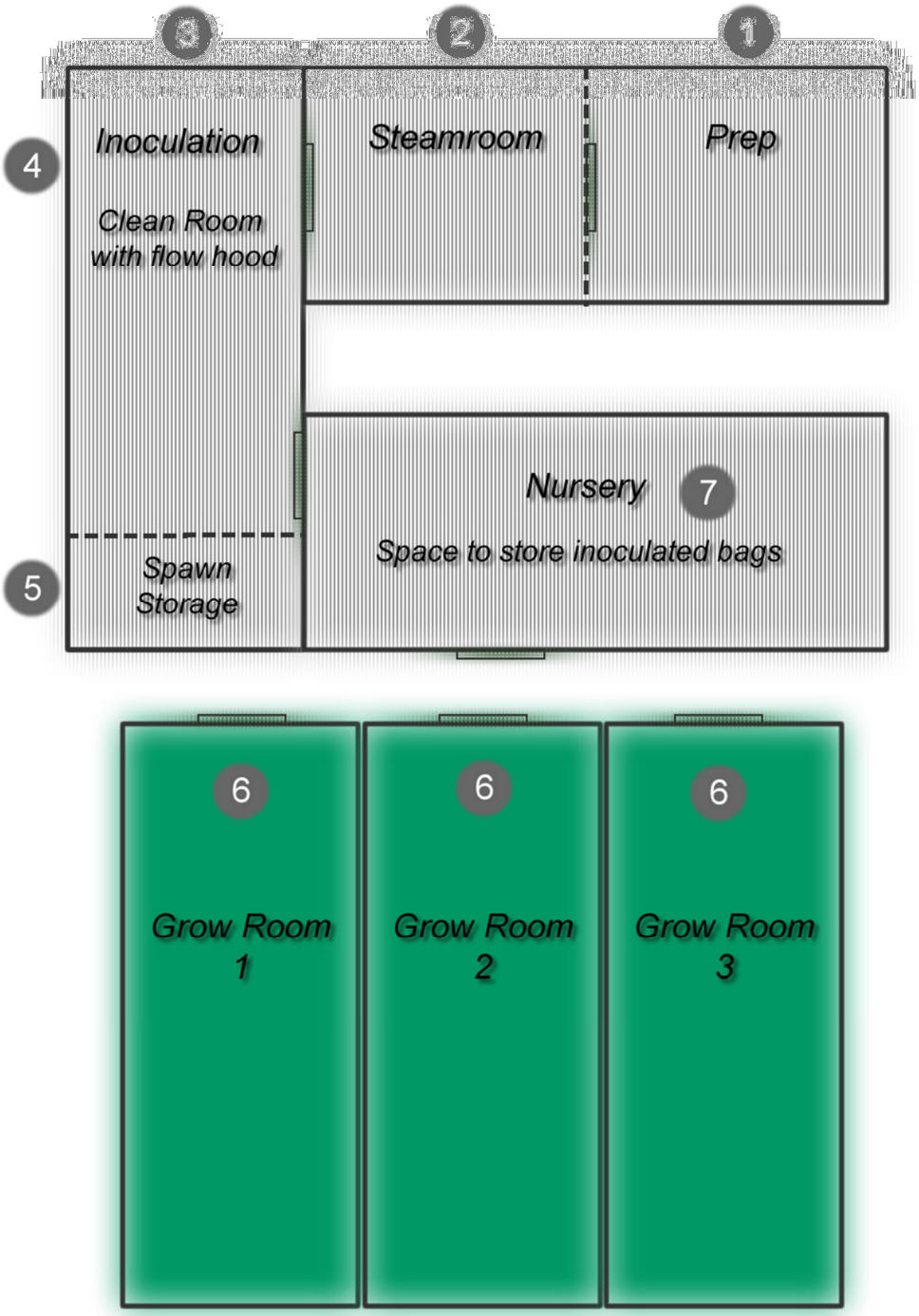
3
2
1
Inoculation
Clean Room
with flow hood
Steamroom
Prep
4
Nursery
7
Space to store inoculated bags
Spawn
Storage
5
6
6
6
Grow Room
1
Grow Room
2
Grow Room
3

Diagram 1

Step 1

a) Build the pasteurization chamber. Use a stainless steel pasteurizer, 210 Lt Drum or cement mixer. Depending on the method used you will need some way to extract the substrate after sterilization. The wet substrate could get quite heavy when soaked and you will need a mechanical chain lift to remove the substrate. This step must be considered and pre planned for in Phase 1.
b) The preparation and pasteurization area must have a concrete floor, and have a drain to easily dispose of excess water.
c) Natural Gas is used in part of the pasteurization process and must be kept away from flammable equipment.
d) Solar heated water will be ideal to use in the production facility for pasteurization and washing up.
e) A Suitable method must be found to allow your substrate to cool, away from insects and out of air draft. It is important to keep your sterilized substrate clean at this time to avoid later contamination that will spoil your harvest.
f) Easy access to the inoculation chambers.

Step 2

a) The Inoculation Chambers must be a semi-sterile space that is only used for the purpose of inoculating your mushroom bags. Before and after each inoculation session, the room must be pressure washed and sterilized using Des-O-Germ™. (This is an environmentally friendly product that can be used in Myco culture.) To accomplish this, the floor must be cemented and slanted slightly for easy drainage.
b) It is customary to use a laminar flow hood in your inoculation chambers, but for a startup project, it will be possible to go without (Pleurotus Ostreatus – Oyster Mushrooms is a very hardy and aggressive culture).
c) The inoculation chambers will need a fresh air inlet – sterilize the air using a 3-micron HEPA filter.
d) A large stainless steel surface is needed to handle your substrate.
e) The inoculation chambers must have a basin and water tap for hand washing.
f) The inoculation chambers must be fitted with a hand towel dispenser as well as equipped with a clean cupboard for sterile overalls.
g) It will be useful to have a door leading from the inoculation chambers to the Nursery for easy transfer of inoculated bags.

Step 3

a) The Nursery is the space where inoculated bags are left to mature before fruiting. Light is omitted completely during this stage.
b) A Cement well drained floor is preferable to aid easy cleaning.
c) The room must be air tight to keep out insect and contaminants.
d) The Nursery will need a fresh air inlet – sterilize the air using a 3-micron HEPA filter.
e) The room must be fitted with racks to keep the bags off the floor.
f) This room must be fitted with a thermostat and wall heating unit to automate temperature variations.

Step 4

a) The mushroom fruiting space will take the larger part of the factory.
b) For the purpose of this project I will consider an open plan grow space. (Diagram 1)
c) The floor will be constructed from cement for easy cleaning. It can be covered with either a fine gravel or Pine/Blue-Gum wood chip that can be obtained from the local industry. This will act as deterrent for snails and have a humidification effect as well. Consideration must be taken for the quality of wood chip as this could be a source of contamination and may have to be treated with Des-O-Germ from time to time to combat Trichoderma (a green mold fungi that often occur on decaying wood matter, is found all over the Garden Route, and will be the main contaminant to avoid).
d) Humidification can be done with high pressure and agricultural misting nozzles suspended high above the bags. It is important to create a fine mist and not have big drops of water settle or drip on the developing and adult mushrooms.
e) The wall separations can be constructed from treated wood and greenhouse plastic sheeting and Isotherm. The construction must me sturdy.
f) Mushrooms need light, if the factory roof does not have sufficient sky lighting available, lighting will have to be provided.
g) Fresh air inlets must be provided to the grow space as developing mushrooms produce tremendous amounts of carbon dioxide, and this gas must be removed from the space.
h) Entry points to the grow space must be screened doorways to deter flying insects from entering. The cause of most of contamination in my experience is when the mushroom fly makes an appearance in your grow room. From observing these little flies, I noticed that they farm and reproduce these molds the same way termites farm mushroom mycelium underground - termitomyces.
i) Easy access from the grow rooms to the exterior of the factory must be created, for removal of spent substrate and if any contaminated mushroom bags.

Step 5

a) The Sorting / Packing Room must be airtight and well screened from insects and other pests.
b) The room must be well ventilated and have a good light source.
c) There must be a basin and fresh water tap. (SABS049)
d) The floor must be tiled and have a proper drainage for easy cleaning. (SABS049)
e) The Sorting / Packing Room need be equipped with disposable hand toweling;
f) Off the floor storage of packaging containers; (SABS049)
g) Stainless steel working surface;
h) Harvesting and processing tools;
i) A Calibrated measuring scale.

Step 6

a) Post processing – Refrigerated chambers to keep spawn and mushrooms.
b) Drying facility to dry mushrooms.

Step 7

a) Spent substrate bags can be emptied outdoors in a designated area.
b) The spent substrate can be turned into rich compost using earthworms and beneficial soil bacteria.
c) A Shade netted area will be sufficient.

Phase 2 – Costing

There is some specialized equipment not included: Herewith the basic Costs Only.

Basic Monthly Costs	
rental - site specific	5500
telephone	600
electricity - availability	2000
water - availability	115
Pest Control	
Mushroom Spawn	
Labor	7920
	16135
Labor - Basic	
3 People	7920
	7920
Grow Facility - Setup Cost	
Prep and Steam Room	3900
Inoculation Room	19500
Nursery	11200
Grow Room 1,2,3	37600
Solar Water System	9400
Air & Filtration	6000
Professional Services	3000
	87600
Prep and Steam Room	
Gas Equipment & Fittings	500
Pasteurization Equipment	1000
Buckets & Lids	2400
	3900
Inoculation Room	
Structure / If not available	5000
Laminar Flow Hood / recommended	10000
Fresh Air Inlet - Spigots and air pipes	1200
Stainless Steel Table	2000

Paper Toweling Dispenser	300
Consumables	1000
	19500

Nursery

Structure	6000
Racks	4000
Air inlet & Spigots	1200
	11200

Grow Room 1,2,3

Structure X 3	20000
Fresh Air inlets & Spigots	3600
Watering system -	8000
Lighting	6000
	37600

Professional Services

Electrical Costs - Wiring	1500
Plumbing Costs	1500
	3000

Solar Water System

1 Pump	2500
3 X 70W Solar Voltaic Panels	2500
2 X 105 ah Batteries	2400
1 X Controller	1000
Wiring	1000
	9400

Grow Rooms will have a capacity to hold 216 Bags

Production

Bags	216	
Average Weight	5	kg
Biological Efficiency	30%	
Total Yield Over Two weeks	324	kg

Price Per Kilo Of Oyster Mushrooms

Kilogram Price		90	R

Total Projected income over 14 days cycle

29160 R

Total Projected income over next 14 days cycle

14580 R

Total Projected income over next 14 days cycle

7290

Total Income over three cycles

43740

Certain Costs are occurred every cycle to produce 216 Bags

Tubing		300
Calsium Sulphate		160
Gas		1400
Ties		300
Spawn	50/KG	5400
Consumables		200
		7760

At a spawning Rate of 10%

Bag weight	*5*	kg
Amount of Bags	*216*	
Total Dry Weight	*1080*	kg
Spawn Needed	*108*	

The Packaging Room, Lockers for staff, cleaning facilities is not within the costing.

Phase 3 – Oyster Mushroom production

Growth parameters – Winter Oyster Mushroom:[1]

Spawn Run:

Temperature: 75° F. (24° C.)

Relative Humidity: 85-95%

Duration: 12-21 days

C02: 5000-20,000 ppm

Fresh Air Exchanges: 1 per hour

Light Requirements: n/a

Primordia Formation:

Temperature: 50-60° F. (10-15.6° C.)

Relative Humidity: 95-100%

Duration: 3-5 days

C02: < 1000 ppm

Fresh Air Exchanges: 4-8 per hour

Light Requirements: 1000-1500(2000) lux.*

Fruitbody Development:

Incubation Temperature: 60-70° F. (10-21° C.)

Relative Humidity: 85-90%

Duration: 4-7 days

C02: < 1000 ppm

Fresh Air Exchanges: 4-8 per hour.

Light Requirements: 1000-1500 (2000) lux.

Cropping Cycle:

3-4 crops, 7-14 days apart, over 45-55 days.

These growth parameters is referenced in Growing Gourmet and Medicinal Mushrooms – Paul Stamets

Substrate Selection:

Our selection will consist of Grass clippings from both municipal source and garden services; Waste Barley grain from Mitchells breweries; Water Hyacinth can be sourced from local dams (tertiary cleanup project); wheat straw can be added when available; waste paper from local businesses and Knysna recycling depot. Substrates may have to be pre dried to some degree before use. Long grasses and straw can be chipped to 3- 4 cm pieces. Use only good looking uncontaminated substrates and remove any substrates that have been contaminated away from the facility.

Pasteurization:

You will need to keep your substrate submerged in 65˚C clean water for 1.5 - 2 hours. Ideally a stainless steel milk pasteurization tank would guarantee results, but using a 210L metal tank would also be sufficient. This process must take place in an area that is draft free and away from any contaminants. Drained water must be funneled to an exterior troth for further treatment or use. It is advisable to have this preparation area in close proximity to your inoculation chambers for easy access. The heated and now sterilized substrate will need to cool down in a clean space that is out of draft and away from insects. The substrate will take about 3 – 4 hours to cool down to below 30˚C before inoculation can take place.

Spawning

Introducing mushroom mycelium to the sterilized substrate is referred to as spawning or inoculation. It is accomplished by adding seed kernels to the substrate that previously was impregnated by the fungi of your choice. The seed spawn kernels are well mixed into the still moist and warm spawn and the bagged in 300mm diameter plastic bags or tubs. These bags are then moved to your Mushroom Nursery.

The Nursery

The inoculated bags will heed some time for vegetative growth. By keeping the constant temperature above 18˚C and below 22˚C, the bags will be ready for fruiting in 14 – 21 days. During this time light is completely omitted, fresh air is routinely introduced to expel the high amounts of carbon dioxide that will build up in the nursery during this time. The humidity can be kept between 60 and 70 RHM during this time. **Care must be taken to keep the nursery free of rodents and flying insects.** Any contaminated bags can be removed of the premises and composted.

Since Trichoderma is a common fungal contaminant in the mushroom growing environment, trying to combat the fungi is impossible. The only way to win is by prevention. Trichoderma has economic value as well as an additive in commercial Peat production and compost making as well as a natural pesticide. Trichoderma also seem to show mycorrhizal activity with plant roots and can improve the general health of plants by activating their host defense response.[2]

Growing out the Mushrooms

Oyster mushrooms prefer a temperature of between 10˚C and 21˚C. The humidity must be kept high during the fruiting phase, between 80 and 90 RHM. Plenty of fresh air must be introduced to expel the carbon dioxide buildup and supply oxygen for mushroom growth. If your room is 10m in length, 5m wide and 3m high, you will have 150m³ of air to replace 4 – 8 times an hour.

Small X cuts, 25mm, are made on the surface of the plastic mushroom grow bag or container to introduce fresh air to the mushroom mycelium as well as a 12 hour light cycle. The combination of lowered temperature, light and fresh air will bump the mycelium into its fruiting stage. Within 7 days small pins are formed that will develop into adult mushrooms within 5 days, depending on the ambient room temperature. Cooler air will produce sturdier, bluer in color mushrooms but will take longer to develop. Higher temperatures may produce adult mushrooms from pins within 3 days. These mushrooms tend to be whiter in color and will lose shelf life as they become more fragile.

Mushrooms are harvested by turning the clump of mushrooms to either side while holding at the base of the mushroom stems. After harvest mushrooms must be kept in the cooling facility at 4˚C until processed.

Phase 4 – Distribution and Marketing

Distribution:

Packaging:

Packaging of Oyster mushrooms for distribution is specific for product freshness and shelf life and is determined by the final retail destination. As the mushrooms continue to give of heat once they have been harvested and need to breath, packaging that accommodates this is necessary. There are two options:

a) For retail sales at supermarket level the PET clam shell with aeration holes in the base. Unfortunately having customers select their own mushrooms out of a large cardboard box does not work for the oyster mushrooms due to their delicate structure and rapid product degradation would occur. Labeling of the product must be in accordance with the laws governing such labels.

Cost:	Clam shell containers	R1.14 ea	Purchased in volumes of 500
	Label Stickers	R1.50 ea	Purchased in volumes of 50 or 100

b) For bulk orders (in excess of 1 kilo) to restaurants & hotels a cardboard box is most efficient.

Cost:	Cardboard boxes	R5.95 ea

The dried or ground mushrooms can be packed in re-sealable Doy packs with a sticker label. These present well as they can stand alone or be hung on a display stand. The re-sealable doy pack keeps moisture out and a good visual on the product.

Distribution:

Fresh Oyster mushrooms are best supported by a local market – in this particular case the distribution range would be from George to Plettenberg Bay, anywhere further would need refrigerated transport.

Hotels Resorts Lodges - Under the auspices of ‘Support Local’ and ‘Naturally Knysna’, the project would benefit greatly from a years’ support from (at least) 5 Knysna hotels/resorts/lodges having a standing weekly/monthly order (allowing for fluctuations during off-peak and peak seasons) The hotels would in turn earn ‘Local Supporter’ credits, have a special Local Grown item on their menu and may create awareness for their own brand through

affiliation. The dried and dried-ground mushrooms would also find a market in this sector being used as vegetarian stock or sauce additive.

Community Feeding Scheme – considering the incredible health benefits of the Oyster mushroom and the fact that it is a complete protein makes it an ideal food for impoverished people especially in a dried ground form, as a stock. The challenge would be to come up with a system of barter or trade that is mutually beneficial to the project and the feeding scheme. A dialogue with all role players would be essential.

Schools – 'Grow your own Food' a project that can be brought into the curriculum at many levels and to various age groups and study disciplines including the study of fungi, mycelia networks & microbial interactions. Purchasing grow bags from the project would be relatively inexpensive – about R35.00 per bag.

Purchasing a grow bag is an economical way for a family to provide themselves with fresh nutritive food. Education on health benefits and cooking methods will facilitate this process.

Markets & Festivals – a great opportunity for education, outreach & promotion as well as offering fresh mushroom sales & food dishes

Supermarkets – unfortunately opportunity is extremely limited here due to the retail outlets policies on food standard auditing and a general closed door policy to supporting local producers.

Restaurants – an extremely fickle market. Very few local restaurants can order and maintain quantities of Oyster mushrooms due to the fluctuations in customer base and cyclical menu changes. There also appears to be a certain amount of ignorance regarding preparation & cooking methods. Ultimately it is the bottom line – cost – and that is where the button mushroom, at R45.00 per kilo comes in at half the price of Oyster mushrooms.

Marketing:

Markets & Festivals are essential for creating branding awareness, customer interaction and education on the many aspects of mushroom cultivation and end product use.

Phase 5 – Expansion and Progression

Expansion and Progression:

Planning for expansion and progression is not within the scope of this document, therefore I will mention only a few things: Planning to move towards energy efficiency takes a substantial outlay, but will return the investment over and over again in time. Certain specialized equipment will be needed in the future e.g. laminar flow hood to ensure successful propagation. Training is essential to the success of a mushroom project.

References:

[1]Growing Gourmet and Medicinal Mushrooms – Paul Stamets

[2]http://www.biocontrol.entomology.cornell.edu/pathogens/trichoderma.html