1 Objective

This Code addresses Good Cultivation Practices (GCP) for Mushroom that will provide specific guidance to promote product safety and quality, ensure worker’s health, safety and welfare and minimize occurrence of microbial, chemical and physical hazards associated with production of mushroom meant for human consumption.

This Code also aims to promote sustainable production and enhance competitiveness of mushroom for domestic use and international trade.

2 Scope, Use and Definition

2.1 Scope

This Code covers relevant practices for the cultivation of mushroom. The provisions of the Code addresses food safety, produce quality, worker's health, safety and welfare and environmental management.

2.2 Use of the Document

This Code considers the relevant provisions of the Penn State University and American Mushroom Institute’s Mushroom Good Agricultural Practices (GAP) Program and other relevant national and private standards for the production of mushroom.

The provisions of this document are supplemental to and should be used in conjunction with the Philippine National Standard (PNS) for Mushroom (PNS/BAFS xx:20__). Relevant provisions that pertain to practices that minimize hazards affecting produce quality, workers health, safety and welfare and environment are expounded in this Code.

2.3 Definitions

For the purpose of this standard, the following definitions apply:

2.3.1 agricultural input

any incoming material like mushroom spawn, agro-industrial residues as substrates, organic and inorganic fertilizers, water and agricultural lime used for the primary production of mushroom

2.3.2 breezeway

means a connection between an accessory building and a principal building that is not heated or insulated and is not restricted by intervening doors
2.3.3 contaminants
substances that include physical, chemical and microbial that are not inherently present
in mushroom

2.3.4 contamination
introduction or occurrence of a hazard into the environment

2.3.5 disinfection
reduction by means of chemical agents and/or physical methods in the number of
microorganisms in the environment to a level that does not compromise food safety or
suitability

2.3.6 farm
any premise or establishment in which mushrooms are grown and harvested and the
surroundings under the control of the same management

2.3.7 hazard
biological, chemical or physical agent in food with a potential to cause adverse effect on
human health

2.3.8 mushroom
visible fruiting body of an edible mold which either grow wild or are cultivated

2.3.9 pasteurization
process of eliminating the vegetative cells (excluding the resistant structures such as
endospores of bacteria and fungal spores) of undesirable microorganisms by steaming
the solid substrates at 60 - 80 degree celsius, for 4 - 6 hours.

2.3.10 pest
unwanted animal, plant or microorganisms that affects the production, quality and
safety of mushroom— for example, insects, diseases, weeds, rodents and birds

2.3.11 primary production
growing and harvesting of mushroom including substrate preparation, inoculation, incubation, watering and harvesting

2.3.12
risk
likelihood of an adverse health effect and the severity of this effect following exposure to a hazard

2.3.13
risk assessment
scientific evaluation of known or potential adverse health effects resulting from human exposure to biological, chemical and physical hazards

2.3.14
sterilization
process of totally eliminating all forms of microorganisms in a solid substrate by steaming above atmospheric pressure (15 pounds per square inch), 121 °C degree celsius for 15 minutes to 1 hour (depending on the nature of substrate and volume)

3 Primary Production

3.1 Environmental Hygiene

Evaluation of the area will be conducted in order to assess if it will pose significant risk to the production of mushroom (i.e. presence of pests) or whether the agricultural activity will have a potential impact to adjacent sites.

The site should be categorized into low, medium or high risk depending on the hazard or contaminants identified and its impact. Recommendation on the actions to take for the risks observed should be made by a competent authority. If the contaminants are found to be at unacceptable levels, the site should not be used for production until corrective or control measures are carried out.

The corrective actions implemented should be monitored for its effectiveness and the results of the monitoring should be properly recorded. If only remedial action is required to manage the risk, the action taken should be regularly monitored to ensure that contamination of the produce is kept within acceptable levels.

Adjacent land, buildings and facilities in the site should be observed and properly maintained to ensure that these will not be sources of hazards. Likewise, the site should be managed to ensure minimal impact to the environment.
3.1.1 Farm Location

The production area and adjoining sites or farms should be evaluated for its suitability for agricultural land use. Moreover, if necessary, the production site must comply with related and applicable regulations of the Department of Environment and Natural Resources (DENR) and Local Government Units (LGUs).

Based on the results of the risk assessment, the primary production of mushroom should not be carried out in the areas where the presence of potentially harmful substances or hazards would lead to: inability to have a viable production or presence of contaminants at unacceptable levels that may affect safety.

In order to assist the farmer in evaluating the possible sources of contamination and/or for monitoring purposes, a property layout map within the site should be prepared to indicate the location(s) of the following, as applicable:

- substrate preparation area
- clean area (isolation and inoculation)
- working shed
- incubation room
- production area (mushroom growing house)
- postharvest processing area
- sources of water used on the farm (well, reservoir, rivers, lakes, farm ponds, etc.)
- solid waste disposal area;
- property buildings, structures, road and canal networks; and

When constructing facilities, relevant local government requirements should be followed.

It is also necessary that remedial action be taken for any identified risk that can affect the environment and worker’s health, safety and welfare. A record should be kept on the actions taken and the results of monitoring. In the evaluation of the production area and adjoining sites or farms, the following should be evaluated for the potential sources of contamination:

- Previous land use;
- Slope;
- Proximity to high risk production sites;
- Potential microbial hazards including fecal and organic waste contamination
and potential environmental hazards that could be carried to the growing site; and

- The access of domestic and wild animals to the site and to water sources used in primary production.

If previous uses cannot be identified, or the initial assessment of growing or adjoining sites leads to the conclusion that potential hazards exist, this should be further substantiated through analysis and characterization of the likely contaminants.

Other considerations on site selection, which may affect the cultural management later are the following:

- Topography
- Soil
- Soil drainage (for volvariella)
- Elevation (temperate/tropical)
- Temperature

3.1.2 Site Selection and Evaluation

During site selection and evaluation, potential sources of contamination from conduct of various operations that may pose significant risk to product quality, workers health and environment and infestation of nearby pests should be identified and remedial actions should be taken to address these.

In particular, the production site should be plain, shady and well-drained. It should be kept clean and maintained regularly. The chosen site, if applicable, should be constructed near a good source of water with well ventilation at all times to ensure the quality of the produce.

3.1.3 Site Management

The name of the farm should be displayed at the entrance. Site signage identifying the farm should be displayed for easy recognition.

Entry of stray animals should be avoided, as they can be sources of contaminants that may affect the production, quality of produce and pose risk to the worker’s health and safety. Waste segregation of biodegradable and non-biodegradable wastes should be provided. Non-biodegradable waste should be segregated from biodegradable waste materials. Biodegradable wastes should be disposed of in a manner that it will not become a source of contamination in the farm. Composting of biodegradable waste is highly encouraged.
3.1.4 Site sanitation

Critical areas where potential food safety hazards exist are needed to be identified and control measures taken to prevent product contamination. Packing, handling, and storage areas that can be sources of contamination should be identified. Cleaning and sanitation procedures should be prepared and followed.

3.1.4.1 Contamination prevention measures

Measures should be taken in order to ensure that the production area is free from possible sources of contamination (e.g. litter, etc.). There should be a control on the vehicular traffic between substrate preparation and growing areas in order to prevent cross contamination. The litter and trash should be covered in containers on well drained surfaces and be removed regularly from the premises.

3.1.4.2 Ground

The ground of the mushroom production site shall be cleaned on a scheduled basis and maintained so it will not become a source of contamination. The grounds should be kept reasonably free of tall grass and weeds, litter, debris, trash, unnecessary stored equipment and standing water.

3.1.4.3 Animals / Pests

Domestic farm and wild animals must be restricted from the production site and from areas where mushroom are prepared, packed, and temporarily held. A kilometer away should be observed to separate the mushroom cultivation area from the animal production site. If possible, barriers should be constructed to prevent entry of animals. The buildings for growing mushroom should be maintained to prevent the entry points for animals and pests. It includes keeping building foundations, walls, roofs and gutters in good repair, exterior doors and windows intact and sealed and outside entrances closed when not in use, or if applicable, have screens installed.

The equipment and other materials should be stored at a sufficient distance from buildings so they will not serve as an entry and eventually a breeding place for pests.

3.1.4.4 Breezeway and growing rooms

The breezeway and growing rooms shall be kept clean and uncluttered. The amount of materials stored in breezeways and staging areas should be minimized in order to have
an adequate space for movement of workers and equipment. A sufficient space between
the interior walls and stored materials should be maintained to allow conduct of pest
inspections.

3.2 Hygienic Production of Mushroom

3.2.1 Preparation of the culture medium

The formulation of an appropriate culture medium should be considered for the
successful cultivation of the fruiting bodies of mushroom. The culture medium should
be prepared in aseptic condition with the use of autoclave or sterilizer in order to obtain
a pure culture of mushroom.

3.2.2 Tissue culture

An important step in spawn and mushroom production is tissue culture. Thus, clean and
healthy fruiting bodies of mushroom should be selected for tissue culture. This can be
done by choosing the unexposed part of the healthy mushroom and not an over-
matured fruiting body. Extra care is recommended when doing tissue culture since it is
prone to microbial contamination. In addition, the procedure should be done in a clean
room with appropriate illumination, controlled ventilation and sterile tools. The
inoculated medium should be incubated at the appropriate temperature depending on
the kind of mushroom desired to be grown.

3.2.3 Choice of mushroom spawn

Aside from yield quantity and quality as basic considerations, species to be grown
should be selected based on market requirements, grower preference and adaptability
to locality. Considerations for choice of mushroom culture are the source, species,
culture generation (up to f4 only) and date of preparation.

If the culture is obtained from another farm or laboratory, a record is kept of the name
of the supplier and the date produced.

3.2.3.1 Grain Spawn

Grain spawn may be made from cereal-based substrates namely unmilled rice, corn,
wheat, and sorghum. The incubation period may usually last for 21 days to 1 month.

3.2.3.2 Planting Spawn

Planting spawn, which is applicable for *Volvariella volvacea*, naturally grows on
decomposing piles of plant residues. Plant residues which underwent pasteurization/
sterilization should be inoculated onto beds, trays or crates of formulated substrates.
Consequently, the spawn should be incubated to produce massive fruiting bodies of mushroom. Incubation period may usually last for 2-3 weeks.

### 3.2.4 Substrate

Raw materials to be used as substrate should be appropriate for the desired mushroom species to be grown.

Unpasteurized substrate should be received and stored as far away as possible from receiving areas where harvest containers, packaging materials, spawn, and other sanitary supplies are received or where mushrooms are shipped.

Where necessary, the substrate preparation areas should be covered to prevent run-off or should be constructed with barriers such as concrete blocks, soil berms, pits, or lagoons to divert or collect run-off. Moreover, ingredients for substrate preparation should be protected from pest contamination and water run-off by storing them in a covered and dry location that is physically separated from other substrate preparation areas.

Substrate preparation procedures shall be based on relevant scientific principles that reduce potentially harmful microorganisms to acceptable levels. Substrate should be pasteurized/sterilized to reduce harmful microorganisms to safe levels.

### 3.2.3 Agricultural Input Requirements

Agricultural inputs should not contain contaminants at levels that may adversely pose significant risk to the production of mushroom such as aspects affecting quality of produce or safety, as far as practicable, worker’s health and welfare and environmental.

#### 3.2.3.1 Water for primary production

The suitability of water for growing mushroom should be tested before usage not less than every six (6) months. If the water quality is crucial for the growth of the mushroom, water should be sampled at least once at the beginning of production and submitted to an accredited laboratory for microbial analysis. Results of the laboratory analysis should be kept and recorded.

The quality of water for production of mushroom should conform to the guidelines set by the Republic Act: 9275 or the Philippine Clean Water Act of 2004. Moreover, the water to be used in the production process should be obtained from a source which is not exposed to any risk of contamination like wastewater from industrial factories or activities that can cause hazardous materials.
The risk of mushroom contamination from the water used for production, washing, cleaning, sanitation and other forms of handling mushroom should be assessed and categorized. Furthermore, the proximity of water sources on possible sources of contamination should be considered during assessment. A record is kept of any significant hazards identified and the assessment of the category where the hazard should be included. If contamination occurs, corrective actions or treatments to minimize the risks should be carried out and documented properly.

3.2.4 Harvesting parameters to ensure produce quality

The quality of the mushroom can be lost at any step during preparation, production, harvesting and post harvesting handling. Injuries from poor handling practices that can cause loss of mushroom quality should be minimized and/or prevented.

Harvest of mushroom should only be done during the right stage of development. Proper harvesting techniques should be employed to optimize the quality and other desired characteristics of mushroom and to prevent possible sources of contamination. Mushrooms that spill on the floor or ground shall be considered contaminated and discarded since these are no longer considered edible.

Materials, tools and equipment used in harvesting practices should be cleaned and designed and handled in a way that it will not pose harmful impact to the produce. Workers should harvest the mushroom with care and assess the quality of the produce prior to post-harvest. Preventive measures for any hazardous contamination should be followed and practiced.

During harvesting, a responsible person should be present to supervise the activity at all times and to assure that harvesters observe hygienic practices.

3.2.4.1 Tools and equipment associated with mushroom production

Harvesting tools, containers, implements and equipment that have direct contact with the mushroom should be cleaned, disinfected and maintained in good order regularly and prohibited from any use other than holding mushroom unless clearly marked. This is to prevent infection of damaged mushroom to undamaged ones.

Reusable harvest containers should be kept in good repair, free of splinters or shards, and cleaned using products approved for food contact surfaces before each use. The cleaned containers should be stored in a clean and dry location where they can be protected from contamination. Containers that are damaged and can no longer be kept in a hygienic condition should be discarded.
Exposed harvest containers in staging areas shall be protected from physical hazards, condensate and floor splash by covering them with plastic or paper sheets to prevent contamination. Moreover, these harvest containers shall not be permitted to have a direct contact with the floor during packing or storage. Stools, carts, pallets or on a dedicated and clearly marked or color coded inverted container should be used to prevent the underside of the harvesting containers from contacting the floor. Movement of the filled harvesting containers from the production areas should be done by placing them on movable carts or by other effective means.

An equipment maintenance program should be in place that ensures that all equipment used to control food safety hazards is in proper working order and does not contribute to product contamination. All equipment used should be maintained and calibrated in a regular scheduled basis. Food grade lubricants should be used on food contact surfaces and machineries.

### 4 Handling, Storage and Transport

Handling of the mushroom should be conducted with the consideration of minimizing contamination and ensuring product quality is maintained. Growers during this operation should ensure that clean containers and equipment are used and efforts towards ensuring that these containers do not come in contact with other sources of contaminants are done.

Whenever applicable, prior to transportation, mushroom should be packed in the field in such a way that it can withstand rough handling during loading and unloading, compression from the weight of other containers, impact and vibration during transport. It should be stored and contained under conditions that will minimize the potential for microbial, chemical or physical contamination.

Damaged containers or transport trailers are replaced as necessary. When not in use, containers and transport trailers should be cleaned, covered and kept in a protected location.

### 5 Post-harvest

Harvested mushrooms may be sorted/ packed on the field or may be transported to a common packing house facility. Mushroom to be sorted out should not be placed in direct contact to the ground/floor to avoid cross-contamination of the produce. Mushroom should be sorted according to the specifications set under the Philippine
National Standard for Mushroom (PNS/BAFS ____: 201__). Damaged and diseased mushroom should be discarded to avoid cross-contamination of the whole lot. Sorters/packers of mushroom should wash their hands with soap or detergent before handling the produce.

The mushroom should be transported using clean and secure trucks or other appropriate mode of transportation. The trucks should not be previously used to transport animals and its products or other potentially contaminated materials unless they are cleaned before loading the mushroom. When transport vehicles are used for other purposes aside from transporting harvested produce, it should be cleaned prior to usage to avoid the contamination of the produce. Moreover, these trucks should be inspected for its cleanliness, odors and dirt or debris before loading the harvested mushroom.

Storage facilities and vehicles for transporting the harvested mushroom should be built in a manner to minimize damage to the produce and to avoid access by pests. They should be made of materials that permit easy and thorough cleaning.

6 Establishment: Design and Facilities

6.1 Premises and lay-out

The design of the production, packing and storing areas of the mushroom should be constructed and maintained to minimize the loss of the quality of the mushroom and, if applicable, the risk of contamination. In particular, the building and its structure should allow thorough cleaning and if necessary disinfection, including drying pavements, to ensure that pathogens do not grow in the facility or on the equipment.

Buildings should be maintained to prevent physical hazards, condensate, and floor splash from contaminating mushrooms. Poison bait stations should be used and located on the outside of buildings.

Grease, oil, fuel and machinery should be properly separated from the production area. In addition, agricultural inputs and substrates should have separate storage areas. Materials used for pest control such as nets, baits and traps should be inspected on a regular basis, maintained and replaced when destroyed. Live traps, glue boards or mechanical traps should be spaced no greater than 30 feet apart along the inside wall of buildings and at the both sides of an entrance, excluding breezeways and growing rooms.

6.2 Drainage and waste disposal
A waste management plan should be developed, followed, and documented including identifying types of waste products generated by property activities and using practices to minimize waste generation, reuse or recycle waste and store and dispose waste. The wastes products should be stored with labels, covered and disposed on a scheduled basis.

Effective waste disposal system should be used and maintained in good condition to avoid contamination. Sewage, waste disposal and drainage systems are constructed to minimize the risk of contaminating the production site and water supply.

7 Worker’s Health, Safety and Welfare

7.1 Labor conditions

Employers must ensure that the working conditions are suitable for the workers. Workers must be treated in accordance to rules and regulations set by the Department of Labor and Employment (DOLE) for the agricultural sector. New workers are informed about the risks associated with health and safety when starting at the worksite.

All workers should comply with the country’s regulation of the minimum working age which is 18 years of age and above. Workers that are below 18 years of age may be allowed to help in the production of mushroom under strict conditions that includes considerations on: appropriateness of assigned work versus the age and physical condition of the worker, duration of working hours, working condition, and availability of supervision and guidance during operations.

7.2 Personal hygiene

All workers should have knowledge, act and maintain an appropriate degree of personal cleanliness. Moreover, workers shall be trained and shall follow the recommended personal hygienic and sanitary practices.

There shall be a strict observance of the “no smoking”, “no spitting” and “no eating” policy inside the mushroom growing and handling areas since these practices will induce contamination.

Any person who has or appears to have an illness, infectious disease or open lesion including boils, sores, or infected wounds, or any other abnormal source of microbial contamination must be excluded from any operations. Hygienic practices through established/documented procedures including specific instructions should be made for all personnel.
Workers should follow personal hygiene recommendations as indicated in the FDA/BFAD Revised Guidelines on Current Good Manufacturing Practice in Manufacturing, Packing, Repacking or Holding Food (AO No. 153 s.2004) or the latest issuance and the Codex Recommended International Code of Practice General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003) or the latest issuance. The following recommendations should include but not limited to:

7.2.1 Wearing of appropriate clothing and shoes applicable to the operation and can serve as protection for food contamination and an aid on the worker’s health and welfare.

7.2.2 Wearing of appropriate masks, hair restraints such as hairnets, caps and bandanas, gloves while growing and handling mushroom.

7.2.3 Prohibition on wearing of jewelry and other personal items that can fall into the product.

7.2.4 Movement of workers and visitors between mushroom growing and substrate preparation or staging areas shall be controlled to prevent cross contamination.

Attention should be given to availability of hand-washing facilities equipped with soap and clean water during before and after all the recommended practices for the production of mushroom. Workers in mushroom growing and handling areas shall wash their hands before beginning work, each time they use the toilet, after any absence from their workstation for breaks or lunch, or after handling soiled materials. When gloves are used in the operation, there should be a proper and regular cleaning and sanitation. However, gloves that are disposable in nature should be discarded after use.

Written instructions (e.g. pictogram on proper hand washing) on personal hygiene practices should be provided to workers. These signs should be posted in prominent locations. Employers should keep track of evidence that hygiene instructions are followed.

First-aid and emergency instructions should be documented and conspicuously displayed in strategic locations.

7.3 Trainings

Upon hiring and on a regular basis, employers and workers should have appropriate knowledge or be trained in their area of responsibility such as operating equipment and tools, accident and emergency procedures and personal hygiene. Training and re-orientation of the workers should be done at least once per year. A comprehensive training in general food safety and food safety control systems to supervisors and
managers. Evidence on the conduct of training should be kept. Moreover, the employers should keep track of evidence that hygiene instructions are followed.

8 Documentation and Records

Where appropriate, records should be maintained to adequately reflect production information, and product information. Maintaining adequate documentation and records of primary production and post-production operations is important in the event of recall of mushroom. Records should be made to facilitate recalls and product safety investigations, if required and should be made available upon request.

Records should be kept on the:

- raw materials;
- types, sources and preparation procedure of substrates;
- sources of spawn;
- type of agricultural inputs;
- water management practices;
- water quality and analysis;
- processing including the date, method and final volume of product; and
- pest control and cleaning schedules of premises, facilities, equipment and containers.

9 Traceability and recall

Each farm should have a program in place for tracking and responding to a need to recall mushroom. A copy of contact information and trace-back procedures required by each packer/shipper should be maintained. Procedures should be developed for rapidly complying with any recall/trace-back requests from customers. Annual mock recalls should be conducted to verify compliance with the standard.
References:


ANNEX A

Laboratory lay-out design

ANNEX B

Right stage to harvest mushroom

<table>
<thead>
<tr>
<th>Species of Mushroom</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Volvariella volvacea</em></td>
<td>Button Stage (Egg-shaped) When the volvariella or the universal veil is not broken</td>
</tr>
<tr>
<td><em>Pleurotus</em> (white, gray, yellow, pink)</td>
<td>Once fruit has opened and formed petal or flower-like stage</td>
</tr>
<tr>
<td>Button</td>
<td>Button stage</td>
</tr>
</tbody>
</table>