Growing Systems Abroad

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Mushrooms are grown all around the world in a number of different systems using a variety of technologies. These systems have developed to suit local conditions and the available technologies when the mushroom industry developed in a particular country. Once an industry has developed in a certain direction it is not always easy to change as it can mean a lot of new investment. Mushroom growing systems can be split into four categories, with a few variations within each category

Wooden shelves using Phase 1 is the predominant system in the Kennet Square area of the USA.

Trays in either metal or wood, which in the past was the dominant system worldwide especially with large fully integrated farms which produced compost, grew and marketed mushrooms all on the same site.

Bag and Block growing, which was and is a common system in developing economies, developed with the advent of Phase 2 tunnels and centralised composting.

Metal shelves or Dutch shelves, which have now become the dominant system around the world, allow a high level of mechanisation of operations and efficient use of substrate.

Wooden Shelves (Penn State Doubles)

Phase 1 compost is produced in a centralised outdoor compost yard and transported to the growing farm, where it is filled on to the wooden shelves at a high kg/m^2. It is pasteurised and spawned on the shelves, spawn run *in situ*, after which casing is applied manually. Generally, it is pinned heavily and large flushes are picked, achieving high yields/m^2 (photo 1). The crop cycle is slow, at around 9 weeks with 2 flushes harvested. It is also vulnerable to disease, especially *Trichoderma*.

Photo 1 Typical wooden shelf system in Kennet Square

Tray growing (Wood and Metal)

Wooden tray growing was and is a widespread growing system around the world. Traditionally, Phase 1 compost was made on site and filled directly into the trays where the compost was pasteurised in a special peak heat room. With the development of Phase 2

tunnels, most tray growing operations switched to performing the Phase 2 in a tunnel as this gave better control of the process and a more consistent compost. The farms had a specialised tray filling and casing lines. Tray farms can be very large with some farms filling more than 1000 t/week of Phase 2. Tray farms working with Phase 2 often have specialised rooms for each stage; spawn running rooms are used, after which the compost is brought to a casing line and placed in a separate case run / pinning room. It is only moved to the final harvesting room when the pins are on the beds, just before picking. Now some farms fill Phase 3 compost into the trays and this is often sourced from a centralised Phase 3 compost operation.

Metal trays have been around for a shorter time than wooden trays but are based on the same principle. A large proportion of the recent investment in metal trays is connected to central picking lines where the trays are brought to a picking line or conveyor system. Here stacks of trays are automatically fed onto a conveyor where pickers pick the mushrooms on a single level before the trays are restacked and returned to the growing room. The main targets of this system are higher pick rates and/or reduced harvesting costs but there is a large hygiene challenge therefore only 2 flushes are taken. There are farms in France, Holland and Spain operating on this system.

Another development of metal trays is Phase 4, where pinned trays are transported to another site for harvesting. The final farm does not need to be as well-equipped and can work on a very short schedule of 2 weeks allowing 26 crops per annum. A disadvantage of Phase 4 is the large transport cost as only half a truck of compost is being transported to the harvesting farm.

Photo 2 Metal tray conveyor system and single tier picking line

Bags and Blocks

Bag and Block growing started when Phase 2 tunnels were developed and this allowed the development of the satellite system where a centralised composter supplied numerous small farms with compost. The investment at farm level was very small especially in Ireland where the climate is temperate and low investment was needed in the growing rooms. Labour requirements are high for filling, casing and emptying and use of substrate is not as efficient as it is on shelves. Bags and blocks suit a developing economy where labour is inexpensive but capital for investment is expensive.

Photo 3 Labour intensive bag production system

Metal Shelves (Dutch Shelves)

The majority of new farms are using metal shelves as the growing system and this has now become the predominant way of growing mushrooms around the world. Metal shelf growing is characterised by high levels of mechanisation for filling, casing and emptying operations, with labour for operations a low % of the cost of production. Mainly designed to use Phase 3 compost some very large farms have been built, with a recent farm in China using 1500 t Phase 3/wk and aiming to grow 500 t mushrooms/wk. Shelves can be anything from 1 to 6 tiers high and rooms of over 1000 m^2 are now common. Rooms can be built using panels or insulated blocks as well as plastic hooped tunnels. If building using panels or insulated blocks, 6 high rooms are cheaper to build per m^2 but then heavy investment in automatic trolleys is required to make picking efficient. Investment in plastic tunnels is lower and often 4 high shelving is used thus avoiding the need for automatic trolleys.

Photo 4 Metal tray conveyor system and single tier picking line

In recent years, some farms have been built either a single shelf high from the outset or ending up as a single shelf after pinning on a 4 high system and winched into final position. The single shelf farm was built using an under-bed cooling or heating system. The main advantage of the under-bed cooling is in controlling the compost temperature during case run and maintaining a high air temperature. This encourages a quick colonisation of the casing, allowing airing in 3.5 days and 2 flush production in 24/25 days. The 2 stage farm involves compost being filled onto 4 high shelves and after 14 days winched to a harvesting room on a single level for picking. The drive behind the single layer growing is to cut harvesting costs through automatic or semiautomatic picking systems. The initial investment in these farms is very high and can possibly double the cost/m^2 of a conventional system. However in a developed economy harvesting is usually around a third of the cost of production and over a 10 year period the total cost of harvesting will be a multiple of between 6-10 times the cost of building the farm in the first place. If an efficient robotic picking system is developed it will be the future for mushroom growing in developed economies.