

Exotic Mushroom Production in Europe Needs Innovations

P T OEI

Chairman, ECO Consult, Tiel, Netherlands, and Visiting Professor, Juncao Institute, Fujian Agricultural University, China. E-mail: info@spore.nl

Abstract: Exotic mushroom cultivation (*Pleurotus ostreatus*, *P. eryngii*, *Lentinula edodes*, *Grifola frondosa*, *Pholiota aegerita*, *Pholiota nameko*) in Europe suffers from imports from Asia, lack of standardized substrate production procedures, labour costs, logistical problems and limited product acceptance. Innovations are needed to increase profitability of the mushroom sector. This article describes several options to innovate in different fields: logistics, quality control, market control, product development and marketing techniques.

Key words: Exotic mushroom production, *Lentinula edodes*, *Pleurotus eryngii*, marketing exotic mushrooms

1 Introduction

Agriculture in general suffers from lack of profitability in Western Europe. Costs have risen significantly, e.g. for energy and labour, while the prices remained stable or have even declined. Two trends can be recognised: up-scaling and diversification. In white button mushroom cultivation, imports from Poland force Dutch and German growers out of business. Especially labour costs are prohibitive: 18 Euro per hour in The Netherlands. Some growers switch to exotic mushrooms, but this market is still quite small. The West European market differs from the world market as described by Chang.^[1] The assortment a Dutch supermarket offers nowadays seems much larger compared to twenty years ago, but the bulk is still *Agaricus bisporus*, although in several appearances (Figure 1).



Figure 1. *Agaricus bisporus* mushrooms on sale in a Dutch supermarket

In Germany, Switzerland, Belgium and The Netherlands, the estimated substrate production for exotic mushrooms per week is ca. 300 tonnes. About half of this substrate is pasteurised, the remaining part is sterilised. At an average yield percentage of 20% the actual production is limited to ca. 60 tonnes a week. In summer however, the production decreases with lower market demand, and in winter it is somewhat higher. German substrate producers sell to Dutch growers and vice versa. It is thus very difficult to distinguish actual production data per

country, as substrate and mushrooms are easily imported and exported within the European Union.

Table 1: Which percentage of the estimated Dutch mushroom farm value of 300 million (€) is taken by which mushroom?

Mushroom species or variety	Percentage of farm value of Dutch production
<i>Agaricus bisporus</i> , white	90%
<i>Agaricus bisporus</i> , chestnut and portabello	5%
<i>Pleurotus spp.</i> Oyster mushrooms	2%
<i>Lentinula edodes</i> , Shiitake	1%
Others: <i>Grifola frondosa</i> , <i>Pholiota nameko</i> , <i>Pholiota aegerita</i> , <i>Lepista nuda</i>	< 1%

Source: informally provided data by mushroom traders

2 Substrate Production

A limited number of substrate producers supply the final growers. Most growers obtain their substrate from these producers, although some produce limited amounts themselves. The larger companies provide ca. 60 - 70 Mt a week. The producers of pasteurised substrate tend to have a short fermentation period of ca. one week before the straw is pasteurised in tunnels at 70°C. They supply oyster mushroom substrate only, in blocks of ca. 18 kg. Some French companies are able to produce shiitake substrate in this way as well, although with the use of chemicals like benomyl. The large Dutch company Pleunis, which built a large shiitake facility in Bree for pasteurised substrate, has long since closed down. They had attempted to grow shiitake in the same way white buttons are produced: on a layer of substrate in shelves; pasteurisation, cooling down, spawn run and fruiting were all done in the same room. The bulk of shiitake substrate is sterilised in some way. Four different techniques^[2] can be recognised:

1. Bulk sterilisation at just below 100°C, container filling under sterile conditions;
2. Bag filling prior to sterilisation, sterilisation in a steamer at just below 100°C;
3. Bag filling prior to sterilisation, sterilisation in an autoclave at 121°C or higher;
4. Dry sterilised beech shavings, mixed with water and 10% of spawn.

If method 1 is followed, bags can be made out of several types of plastic as they are not heated, and even buckets are used by a Swiss company. If method 2 and 3 are followed, the plastic has to be able to withstand the heat. Depending on the amount of plasticizers, the bags remain flexible or very brittle after the sterilisation process. If method 4 is followed, no expensive bags with filters have to be used, simple PE bags with micro perforations will do.



Figure 2. Shiitake substrate blocks of 15 kg each, prepared on dry sterilised beech shavings

The costs of spawn are considerable with this method, as it serves as a supplement as well.

3 Factors Affecting Substrate Production

The profitable production of high quality exotic mushrooms on a sterilised substrate depends on several, interacting factors:^[2-5]

1. Substrate recipe: coarseness of main ingredient (mostly beech wood sawdust), supplements, water content;
2. The substrate containers which define the form of the substrate blocks and the aeration during spawn run;
3. The sterilisation system (see above)
4. The spawning system: top spawned with grain, through spawned, liquid spawn or wooden stick spawn;
5. The logistic system: how the substrate containers are transported after filling until opening at the farm of the mushroom grower
6. The yield and quality of the mushrooms.

Most substrate producers use different procedures in their process and it thus becomes more difficult to learn from each other. Without standardisation, each production unit has to reinvent the wheel. The substrate recipes are kept secret and limited use is made of scientific research. For example no manganese is added although its potential effect on yields is well known.^[6]

4 Logistics During the Cultivation Process

A very important aspect of European production is that logistics have to be developed in such a way that labour costs are minimised. Growing in small plastic bags does not help in this respect. The Dutch have developed much equipment to handle large amounts of pasteurised substrate. A complete growing room for *A. bisporus* can be filled with 20 tonnes of substrate within a few hours, figures shiitake growers can only dream of.

As the bag filling is labour intensive, most substrate producers have increased the amount of substrate per bag compared to East Asia and the US. The small standard blocks of ca. 1.2 kg are only found in Finland; most producers fill up to 5 kg per bag. The Swiss company Romanens manages to use buckets with 15 kg of substrate. Aeration is provided by a foam plug. It is important to notice is that the company uses rather coarse material (beech wood pieces of several centimetres), which aerates better than the usual beech sawdust.

4.1 Filling systems

Filling containers is mainly done by keeping the bag by hand below an opening spout. For bottles, special equipment has been imported from Asia; however, only two growers in Western Europe use bottles: a Japanese grower in Belgium and a *Flammulina* grower in Denmark. The Asian machines for filling bags from Taiwan do not meet EU safety standards.

A new filling machine was developed by Lou Hsu of Unicorn in 2004, and several growers in the US use a so-called Form, Fill and Seal (FFS) machine to produce a bag around the substrate and subsequently close the bags automatically. In Europe, we developed a similar system with a well-known producer of packaging machines for the food industry, Audion. This system can fill up to 20 bags of 3 kg per minute. FFS machines are not new: they have been used in the food industry for over 20 years. They have proven to be reliable, as few moving parts and automatic operation provide a steady workflow as long as the roll of plastic is kept in the right position. An important advantage is the lower cost of substrate packaging; actually, the substrate producer makes his own bags out of a roll with the filters already on it. Savings on the substrate packaging are in the order of 30 - 40%. Critical is the choice of the right type of filters for the substrate containers. Some growers did not manage to find the right type of filter and had problems with bags exploding during the sterilisation process, due to changes in pressure and limited air exchange. Some now use a B-type of filter, which has a very high air exchange.

4.2 Spawning

Most growers use grain spawn in varying quantities. The amount of spawn also depends on the type of mushroom: some growers use only 0.5% spawn for *Pleurotus cornucopiae*, 1% for *P. eryngii* and 1.5% for *L. edodes*. Clearly the growth rate is reflected in the spawning rate. When using Method 4, with preheated wood chips, a much higher percentage of spawn has to be used. It is important to understand is that the spawn not only acts as the inoculation material, but also as supplement.

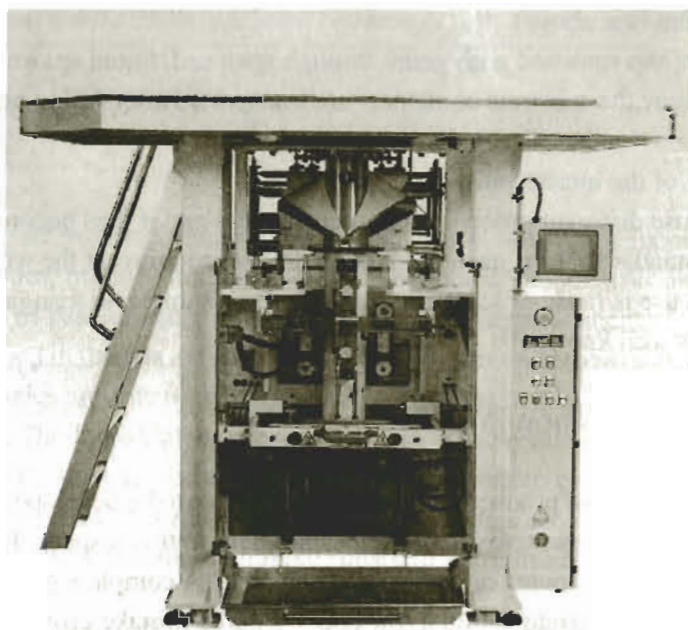


Figure 3. Form Fill and Seal machine

The machine can fold a sheet of plastic around the substrate and form a sealed bag. The plastic has pre-mounted filters at regular distances. Courtesy: L. Hsu, Unicorn.

Some producers experiment with wooden sticks to inoculate, as these only have to be pushed in the bags. The sticks are 4mm in diameter with a length of 160 mm, pointed on one side only. The remaining hole in the bag is closed with an adhesive, all in all a labour-saving spawning process. An additional advantage is that the wooden stick spawn is cheaper and can be transported without cooling.

Liquid spawn is not easily available, and the original high expectations from the 1980's have not turned into reality. Liquid spawn cannot easily be stored, if contaminated the complete batch is spoiled, and contaminations are difficult to detect. Finland is the only European country where liquid spawn is common. In other countries no reliable large-scale production unit for liquid spawn is present.

4.3 Spawn run and block form

The substrate produces much heat during the spawn run, and *Pleurotus* substrate especially needs to be cooled during the spawn run. As a rule of thumb, 1 kW of cooling is necessary for shiitake and 2 kW for *Pleurotus*. The use of 5 kg substrate in more or less square blocks means that the temperature inside the blocks can be 10 degrees centigrade higher than the air temperature. Some producers therefore decided to produce rather flat blocks, which do have the advantage that the temperature distribution is more even, but tend to break more easily during transport. It is essential that the whole process, from filling bags to distribution and taking off the plastic from the substrate, is studied for more efficiency. Most substrate producers have developed a system to

dispatch their bags quickly. Some use flower carts from right after spawning until the bags arrive at the farm. However, no standardized system exists as of yet.

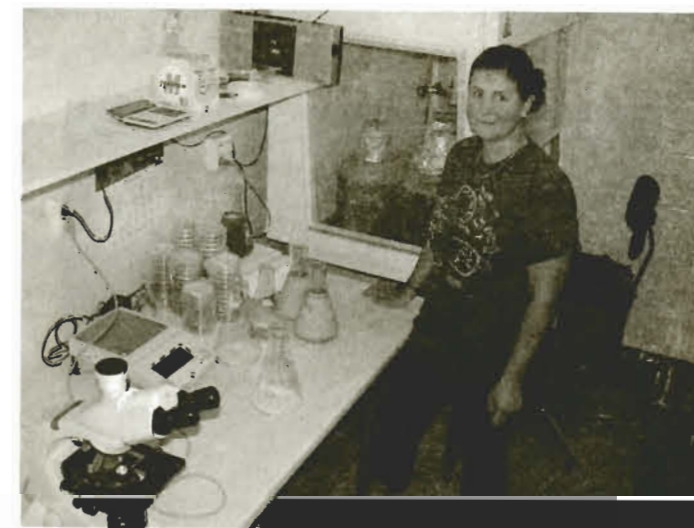


Figure 4. Liquid spawn preparation in Finland. Courtesy: H. Makela.

4.4 Harvest and marketing

For some mushrooms, like *Pleurotus eryngii*, cooling is essential to obtain a good flush. As the market is small, growers often have more than one type of mushroom in their growing rooms. It thus becomes more difficult to adjust the climate to the specific need of each individual strain or species. The solution is to have smaller growing rooms with individually controlled climates, without excessive costs.

Labour costs also determine the treatment of shiitake. Although submerging the blocks under water for one day is the best way to stimulate a second flush, some companies use heavy spraying. With labour costs as high as 18 Euro per hour, it is essential that picking is done efficiently. Some strains, which produce well, produce rather small shiitake and thus increase picking costs. A strain that actually produces fewer kilograms may thus be more profitable for a grower.



Figure 5. Flower carts with mature shiitake substrate at CNC Exotic Mushrooms, Netherlands

The substrate is placed on the carts right after filling and stays on the carts until it is put on shelves in the growing unit. A trend can be noted that oyster mushrooms have to be packed for retail marketing in small boxes and the grower still gets the same price as he used to get for bulk packages of oyster mushrooms some years ago. Some biological certified growers try to work around this problem and now pack bundles of oyster mushrooms with the caps turned upward. This saves labour costs as the stems do not have to be cut from the mushrooms,

it increases shelf life and the growers has more kilograms for sale. At one farm, the picking rate also increased much to 50 kilograms per hour for bundles of oysters, compared to a modest 15-20 kg per hour for oyster mushrooms which are cut loose. New methods to induce a higher yield with electro stimulation¹⁷¹ are not practised yet.

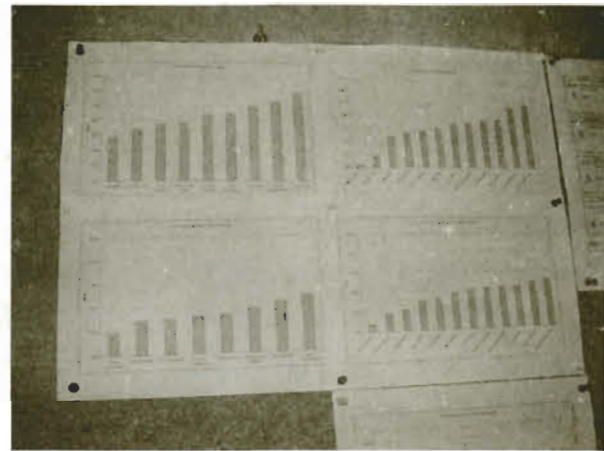


Figure 6. Modern farm management includes monitoring picking yields of each individual picker



Figure 7. Researcher J. Kynast with yellow oyster mushrooms at Pilzgarten Helvesiek, Germany

5 Innovations in Marketing

A product innovation from Pilzgarten in Germany from October 2004 is the new packaging for the retail market. The fresh mushrooms are sealed below a so-called barrier foil, which slows the metabolism rate down. The mushrooms can now be stored (under cool conditions) for up to three weeks and still maintain their properties. The foil is micro perforated by a laser and it allows some air exchange: the oxygen level will not drop below 5% and this will slow down the metabolism rate, without inducing anaerobic processes. Special machines are available to seal the consumer packages with the special foil.

Simple product innovations are mixed mushrooms in one package; in this way the wholesaler can adapt the

exact content to what is available on the market. Beautiful yellow and pink oyster brighten up these packages, and these two species are being sold together as Oriental oyster mushroom mix in the UK. A very simple method to increase attention in the supermarket is to add small amounts of fresh parsley; this green herb gives the whole package a fresher appearance.

The packaging of bundles of oyster mushrooms with stems was already discussed above; the selling point for the buyers being the longer shelf life and the nice looks of the oysters. More complex product innovations follow the trend for convenience food. The food-processing sector innovates constantly, but it seems that using exotic mushrooms is not so much the decision of the mushroom sector, but of the food-processing sector itself. Creative ideas should be brought forward by the mushroom sector: why not upgrade an ordinary mushroom sauce with some slices of cheap Chinese truffle, baked in truffle oil? However, it is important to note that strict application of HACCP may block several options.

6 Subscription Services

A success story from the biological sector in The Netherlands is the subscription service provided by organic vegetable producers who deliver to Odin, an organic food distribution company. More than 20,000 consumers subscribed to their package of different vegetables and fruits, which is sufficient for four days. Experience has shown that the package should not contain food for more than four days, as people still like to choose other products. The package is distributed via health food stores. The price is relatively low compared to buying loose organic vegetables but higher than buying organic products. The main advantage for the growers is guaranteed sales and the wholesaler can choose what is available for the packages. Extra packages have been introduced for fruits but were less successful. Local organic vegetable growers also stepped into this market and supply many thousands of households with food from their direct surroundings. Up to now, only some brown button mushrooms were sometimes included in the vegetable packages. Exotic mushrooms are too expensive compared to the other vegetables in the package. At the end of 2005 a pilot is planned with mushroom subscriptions as an addition to the vegetable packages, for which extra has to be paid.



Figure 8. The modern design of the five different subscription types for organic vegetables and fruits, as marketed by Odin, the Netherlands

7 Distribution Patterns

Most Dutch consumers buy their mushrooms in supermarkets. The public keeps the price of a 250 gram white

button mushroom as a reference. Therefore, more expensive mushrooms are packed in accordingly smaller amounts: oysters 150 grams and shiitake only 100 grams. Recent trends in the supermarket sector in The Netherlands are discounters and budget supermarkets. *Agaricus bisporus* (250 grams) are on sale for only 0.49 Euro. The cost cutting affects the producers as well as the supermarkets: according to the branch organisation CBL 10,000 jobs have been lost in supermarkets since the price war between supermarkets started, as service is considered less important than price. Some growers start to sell mushrooms directly to restaurants and on markets, but this is time consuming and it is difficult to plan the production for a fluctuating demand.



Figure 9. Direct sales from this French grower to consumer on markets is time consuming but financially rewarding

Still the market of exotic mushrooms is growing. When this happens, existing logistic advantages for local producers may decrease and Asian imports may take over. The local producers should counter by promoting locally produced food and an excellent distribution network.

8 New Packaging

As exotic mushrooms still have limited market appraisal, the VPN (Federation of Mushroom growers) started an initiative to improve packaging. More information on the health aspects and a more attractive look and feel in the supermarket will increase sales; at least this is the hope of VPN. Together with the new sleeves, a website with recipes will be promoted.

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