

The situation in Hungarian mushroom production and possibilities of development

Preliminaries and objectives

For 25 years I have been dealing with edible mushrooms and have gained ample experience in the field of mushroom production in Hungary and have also got acquainted with the situation abroad especially in Europe. Besides my laboratory tasks I was able to study - as head of mushroom protection - the technological phases of mushroom cultivated in Hungary, the problems of variety maintenance, spawn production, compost making, oyster mushroom and shiitake substrate preparation and production.

The 10 years between 1990 and 2000 were the most important and resulted in making mushroom production a success in horticulture.

Since the reports of Balázs (1974 and 1982) and Tasnádi (1985) no comprehensive studies appeared to analyse the mushroom situation. Publications were continuous but incomplete. This fact encouraged me to try to sum up the technical-technological changes in the Hungarian mushroom production in the 25 years but more especially in the 10 years past.

Data were collected of mushroom production in the world and the most important species in cultivation. Production indices of the USA are presented, and changes in cultivated mushroom, oyster mushroom and shiitake cultivation in Europe described. I was especially interested in data of the countries, which can have an influence on our own production.

The Netherlands deserves special attention as the country on top of the European list of cultivated mushroom quantity. In some 10 years a unique background industry was established, resolute research carried on and, last but not least exemplary education in mushroom growing was organized.

The Hungarian fresh mushroom export is highly influenced by production and consumer trends in Germany. Germany is the most important country to import fresh and canned mushrooms in Europe.

In France, the original home of *Agaricus* production, growers face economic difficulties. Production structure is in many ways similar to ours. For a long time mushrooms for processing were cultivated and now as fresh mushrooms are wanted they are unable to compete with the Dutch in quality.

Production in Ireland is impressive. Organization matches with rationality. Production in polyethylene bags (now considered out-of-date) is quite profitable in the relatively cheap plastic tents. The satellite system is well organized. Fresh mushroom of excellent quality are demanded on the English market. We ought to adapt some of their organization and technical solutions.

In Spain the joining the European Union stimulated *Agaricus* and *Pleurotus* mushroom growing. In backward regions hundreds of new work places could be established. Unfortunately, climatic conditions do not allow an economical, all year round production.

Mushroom production in Poland has been a potential rival for 20 years. More and more cultivated mushrooms are grown and exported, especially to German markets.

I sum up the history of 100 hundred years, its results and technological changes in Hungary but I want to concentrate on the period between 1990 and 2000 as being very important.

Basic changes occurred in the 1990s with the expansion of export markets and an increasing production. Changes were the most remarkable in *Agaricus* cultivation. New, up-to-date compost farms and new production regions were established. Mushroom yield increased sevenfold and the export quantity twenty-fold resulting in considerable dollar income.

In 2000 the Hungarian mushroom production reached a point where decisions must be taken to define the way to follow, at least, for the next 10 years.

In 2000 about 38 000 tons mushrooms were grown in Hungary of which 17 000 were exported fresh. The export income of fresh *Agaricus* and *Pleurotus* amount to 22 % (in US dollars) of the total fresh vegetable-fruit export and to 34 % of fresh vegetables. More first quality fresh mushrooms could be sold in West European markets if our means allowed it but, unfortunately, though we have compost farms if high capacity technologies have not changed. Even today production in cellars prevail. The establishment of the Dutch-type surface growing houses requires capital and high investments. The 30 % not-to-repay State support granted by an FVM order in 2001 is not sufficient to realize a growing house program. Plastic tunnels are more advantageous in price but they have the disadvantage that in the hot summer months no proper climate can be guaranteed in them as required in the different phenological phases of the mushroom. A continuous production is doubtful despite surplus costs. Further problems are caused by the bag culture on one level as it is labour intensive and houses cannot be fully exploited.

From the point of view of environmental protection the huge quantities of spent compost (200 000 tons/year), *Pleurotus* substrate and polyethylene bags (about 500 tons/year in *Agaricus* cultivation alone) cause severe problems.

In *Agaricus* production the use of the III. phase (spawn-runned) compost may eliminate the problem of polyethylene bags. Further investments are needed from the part of compost farmers and growers alike. Similar to shelf production on several levels the use of the III. phase compost is gaining ground.

Another important question is the introduction of the chemical free, so-called integrated, production method now adapted in the countries of the European Union. Future aims must involve the adaptation of the integrated production as well as the proper management of spent compost and substrates.

German and Austrian markets are demanding „leafy” oyster mushrooms (*hungaricum*). Further developments will include substrate farms of high capacity and the construction of climatized houses.

Considering world trends the cultivation of other edible mushrooms hardly surpasses amateur levels. Shiitake production is gaining ground but improvements are needed.

Mushroom production in Hungary can be as high as 100 000 tons/year by 2010. According to some western experts the European Union is at present short of 50-60 000 tons cultivated mushroom. We could be able to cover, at least, a part of it but not any price. The Netherlands is producing more and more and cheaper and cheaper and Poland is our first rival in this field.

Mushroom consumption at home increased in 10 years. It is at present nearly 2 kg/person. When speaking about mushrooms we mostly understand *Agaricus*, the cultivated mushroom. Consumption could be increased, even doubled in modern diet. If we consumed 100 g more a week (it is not much) the per head consumption/year would reach 5,2 kg which could be covered by the production of 52 000 tons. If the export possibilities remained at the level of 1999-2000 (18 000 tons/year) the production of 70 000 tons would be motivated by 2010.

Methodological steps

In my article data published in foreign journals (*Der Champignon*, *The Mushroom Journal*, *Mushroom News*), Hungarian scientific publications, books, Internet or issued by the Statute Office of Ministry for Agriculture and regional Development are summed up and classified. Foreign sources are useful when dealing with mushroom production of other countries. *Agaricus* plays a very important part as it is still and will remain for a long time, the most popular mushroom not only in Hungary but also in the whole world. Being in a happy position as an active participant in mushroom production I am able to use my own notes and/experiences in the past 25-10 years to describe the history of the Hungarian mushroom growing.

In 1994 about 30 different mushroom species were cultivated but only **about 10 of them** have market importance with a share of 95,2% of total production:

- **37,6 % *Agaricus bisporus*** (including *Agaricus bitorquis*),
- **16,8 % Shiitake**, *Lentinula edodes*,
- **16,3 % Oyster mushroom**, *Pleurotus* spp.,
- **8,5 % *Auricularia* spp.**(mostly *Auricularia judea*),
- **6,1 % *Volvariella volvacea***,
- **4,7 % *Flammulina velutipes***,
- **10,0 % *Tremella ficiformis*, *Hypsizygus marmoreus*, *Hericium erinaceus*, *Pholiota nameko* and others.**

Of the **10 species 6 can be said** to be **important: *Agaricus*** (both *A. bisporus* and *A. bitorquis*), **shiitake**, different **oyster mushroom** species, ***Auricularia* spp.**, ***Volvariella*** and ***Flammulina*** coming up to **90 % of total yield**. The cultivated mushroom, *Agaricus*, cultivated in the highest quantity has kept its leading position for several years though its share tends to decline.

In **1994 the world production was 4,9 million tons** with a value of 9,8 thousand million US dollars. If we add to this sum the 3,6 thousand million US dollars of different mushroom products it is obvious that mushroom growing has become an industry. Now the term „mushroom industry” is generally accepted without questioning it.

Mushroom production in **1997** was more than **6,3 million tons**. Of this 4 million tons (more than 63 %) were produced in China with the countries of the European Union on the second place (900 000 tons, 14 5 untrimmed weight). North-America (Canada, USA) produced about

430 000 tons (about 7 %) and other countries contributed by 16 % to total production. Of the latter countries Mexico, Indonesia and India deserve attention.

Six countries (**USA, France, Canada, Germany, Great Britain and Italy**) sell about 65 % of their mushrooms and so they have a decisive influence on the mushroom production of the world.

In the countries of high mushroom consumption attention has turned to exotic mushrooms (*Pleurotus* spp., shiitake, *Volvariella*, *Flammulina* and different medicinal mushrooms). Thus, it is no wonder that the production and export of such mushrooms increased drastically in the Far East.

The most important mushroom is the cultivated mushroom. *Agaricus bisporus* was cultivated in more than 2 million tons in 1995. Between 1960 and 2000 production increased ten times. Member of the European Union are leading with 842 000 tons in 2000 (trimmed), followed by China (500 000 tons) and the USA (388 000 tons).

Production data of the European Union including Austria, Belgium, Luxembourg, Denmark, Finland, France, Holland, Ireland, Great Britain, Germany, Italy, Spain and Sweden are collected by the Groupment Européen des Producteurs de Champignons = GEPC. Three countries, Austria, Finland and Sweden, with their hardly 10 000 tons production have practically no importance in production but they must be reckoned with as markets.

In the EU countries the Netherlands are at the head with their 30 % share of production. Mushrooms are not only grown but exported as well fresh and canned. The Netherlands affects prices on continental markets. France is at the second place and Italy at the third in export competing sharp with the Netherlands. It is obvious that new rivals will soon appear with Poland and Hungary.

In the EU countries 57 % of the 843 000 tons produced in 2000 was consumed fresh and 43 % processed or deep-frozen. **1,3 kg fresh mushroom/head/year** was consumed in **2000**.

In Europe ***Pleurotus* has been cultivated** for nearly 30 years with increasing tendency between 1980 and 1996 and a slight decrease in 1997. For 10 years Italy has stood at the first place partly due to the method elaborated by two Hungarian expert groups (HTTV process, patent of Balázs, Kovácsné Gyenes, Tóth). Spain achieved a sudden success increasing yield with 230 % and winning thus the second place with France at the third.

Shiitake production began 15-20 years ago with varying success. Yield stagnated at the same level in the different countries. The slow increases is due partly to failures in technologies and partly to lack of interest. Consumers are reluctant to buy it and the stiff prices also discourage buyers.

In Hungary *Agaricus*, *Pleurotus* and *Lentinula* are produced at present. In 2000 production amounted to 38 000 tons of which 92-93 % the cultivated mushroom, 6-7 % oyster mushroom and 1 % shiitake. In negligible quantities some other species are also found (*shaggy ink cup*, *Ganoderma lucidum*, ect.).

Our mushroom production is based on the cultivated mushroom. At present there are **5 important growing regions** in Budapest, Eger, Győr, Máriakálnok including Szigetköz and

Pécs with their surroundings. **Oyster mushroom production** has its **centre in Kecskemét** and **surroundings** but it can be found everywhere in the country.

In the year **2000 mushroom production booked 17-18 thousand million Hungarian Forints**: 4,5 thousand million for compost, 6 thousand million for fresh mushroom and canned product export, also 6 thousand million for inland markets and about 1 thousand million for spawn export, casing soil and chemicals all together.

Mushroom production in Hungary can look back upon 100-year-old history. At the beginning horse manure was used exclusively as substrate in wooden sheds and other surface houses. Later the French model was adapted and large quantities of *Agaricus* were cultivated in artificially dug out limestone cellars. The first mushroom farms were established in Kőbánya and later in Budafok and Budatétény. A real boom began after the I. World War when **László Makó** managed to produce high quality, pure spawn, and production became reliable.

Hungarian mushroom production had its height between the I. and II. World Wars when in 1938 Hungary was the third largest mushroom growing country with the 1 200 tons/year just behind France and the USA.

Three big firms dominated: the Makó Bros., the Suppan Champignon Kultura and the firm Zalay. All the 3 of them had their own spawn laboratories, processing and export facilities. Fresh mushrooms were exported to Vienna markets.

In the last years of the II. World War production almost came to an end. Cellars were used as air-raid shelters.

In the 1950s a new chapter began. After nationalization it was the Mushroom Growing Company, which dealt with spawn making and research. Hungary was the first in the world to collect *Agaricus* species and varieties found in nature for breeding purposes.

Imre Heltay worked out the so-called short composting method in 1956 based upon Sinden-Hauser's short composting method. The traditional 17-30 day long composting time could be shortened to 16 days. With the new method 6-8 kg mushroom/100 kg compost could be harvested instead of 3-4 kg.

In 1967 the Coop Farm Duna in Csepel took over the leadership and kept it till 1990. In this period new technologies were introduced, such as the heat treatment in boxes, polyethylene bags, mass heat treatment, just to mention the most important ones. In 1975 the Coop Farm Duna became the head of the Hungarian mushroom production system. It helped establish compost farms in Pécs and Győr and supplied growers both with spawned compost and advice how to grow them. Due to new technologies mean yield increased: in heat-treated boxes to

13-15 kg/100 kg compost and to 15-18 kg in bags. The mass treatment method and poultry manure as N-source, increased *Agaricus* yield to 16-20 (22) kg/100 kg compost at the end of 1980s.

Coop Duna also operated a **test laboratory** where activities included research on ***Agaricus*, *Pleurotus*, *A. bitorquis*, shiitake** and **other species**.

The collection of mushroom in nature begun in 1950s was continued and by the mid 1980s **385 different *Agaricus* strains** collected or obtained from abroad were in the possession of the laboratory.

They also dealt with theoretical and practical problems of **plant protection** and **worked out a general control technology** for the whole country and had some new chemical introduced.

In the **breeding of Pleurotus varieties** Pál Gyurkó played an eminent part. Of his more than **200 Pleurotus strains** several ones were released. His strain **HK 35** (present name Duna HK 35) is still **the most widely cultivated Pleurotus variety in Europe**.

Pleurotus production also began in the 1960s when Hungarian scientists worked out interesting technologies to produce substrates. All the 3 methods are patented:

- **sterile growing technology** (HTTV process, Heltay-Tóth E.-Tóth L.-Véssey),
- **microbiological heat treatment** (Pál Gyurkó and workers of Coop Duna, in the first place Mrs. Koronczy),
- **dry heat treatment** (patent of Balázs- Kovácsné, Gyenes-Tóth).

All of them contained elements, which protected the oyster mushroom against different competing and antagonistic moulds. Today the dry heat treatment is in general use in Hungary.

Spawn production also began with the development of growing methods in 1970s. Pleurotus spawn is made in Coop Farm Duna, the Vegetable Crops research Institute Kecskemét, Borota, Pécs, Gödöllő and Törökbálint.

The **first independent oyster mushroom farm was established in 1973** and led by László Tóth in **Borota**. Even today it is the biggest substrate farm producing high quality substrate. Unfortunately, demands now surpass its capacity.

In the late 10 years very important changes occurred in **compost production**. New, high quality spawn laboratories also contributed to the dynamic development of mushroom production. Due to the geographical situation of new compost farms, new growing regions originated but prosperity also started in traditional regions. Cultivation technologies changed, mean yields increased. Besides the new and traditional regions Agaricus is now generally cultivated. Our compost farms are now equipped with the latest Dutch techniques, modern machines and are able to satisfy the highest demands. Our experts also contributed to the success. By 2000 the problem of the computer steering of compost production could be solved. Observing strict rules quality compost of good productivity can be delivered to growers.

For years compost farms have sold heat-treated spawned II. phase compost. Now the **III. phase compost** appeared. It is actually compost interwoven with Agaricus mycelia. Incubation takes place in bulk at the compost farm and not in polyethylene bags at the grower. Mass incubation takes place in heat chambers.

Of late years the **pressed block** appeared. Spawned compost is pressed into blocks and put on shelves one above the other. Blocks can be transported on pallets but their handling is somewhat troublesome. Almost 100 % of the compost export is in blocks. In the county Győr-Moson-Sopron, the second largest mushroom region, 50 % of the compost used was blocks and 50 % in bags in 2001. Block technology can be applied in mushroom houses as well as in transformed stables.

In Hungary 8 compost farms were in operation in 2000: in Áporka, Csikvánd, Győr, Hódmezővásárhely, Kerecsend, Máriakálnok, Pécs and Tök.

II. and III. phase composts and pressed are made. In 2000 200 000 tons Agaricus compost was produced in Hungary according to estimation and personal communications.

There are opinions that the introduction of aired I. phase compost or pit method was the most important step in these 30 years. It was first used in 1995 in different countries, in different ways but based on the same principle. The process in pits is similar to that in traditional composting method. This new technology is used in Áporka, Győr, Kerecsend, Máriakálnok and Tök.

Till 1990 mean yield was 18-22 kg/100kg compost. Then, due to the pit technique, technological changes and III. phase compost **yield increased to 28-34 kg/100 kg compost in 2000.**

Conclusions, recommendations

The Hungarian mushroom, similar to other agricultural products, may soon have to fight not only for coming to foreign markets but also for keeping them. Steps ought to be taken now to be able to hold our present, more or less favourable, market position.

Based on my work the following conclusions can be drawn.

1. Modernization of the cultural technologies

One of the most **essential problems** is how to modernize the **bag technology** and the **cellar culture**. Cultivation in bags, which was at the time of its introduction a necessity and a revolutionary step, has now become rather problematical.

The **method is extremely labour intensive**, the conveyance of material is complicated and mechanization is hardly feasible. Wages keep on increasing and in 10-20 years nobody will be willing to do heavy manual work in cellars under present conditions. The reduction of per unit costs also requires some innovation. Production on shelves could succeed to bags, at least partly, that would also increase demand for III phase compost delivered bulk. In cellars blocks could be a solution.

In cellars with the one-level production system the surface area cannot be fully utilized. Besides higher energy costs and rent payment this point cannot be neglected, either. Hygienic problems labour shortage, limited mechanization all contribute to aggravating the situation. Moreover, not every cellar is adapted to continuous, year round production.

Cellar cultivation has, however, advantages as well. Cellars are easily available, modernization does not require high investments (conditioning), energy costs are still lower than houses. With proper know-how **firsts quality mushrooms can be produced** for fresh market.

Considering the economic situation it must not be forgotten that the mean price for Agaricus stagnates or is decreasing everywhere. We cannot avoid the challenge, but how to produce excellent quality mushrooms more efficiently, at lower costs?

Our compost supplies can satisfy growers in every aspect since international standards have been introduced. Unfortunately, that cannot be said of our growing rooms. What possibilities have we got, that is the question.

Surface growing houses or **plastic tunnels** ought to be built. Growing houses can meet every requirement (efficient, uniform), but investment costs are too high. Growers cannot afford them of their own sources, efficient support from part of the State is needed. Tunnels are much cheaper, but have a short lifetime.

In Agaricus production it is a worldwide trend **to separate compost making and mushroom growing**. Some farms deal exclusively with compost, or, perhaps, purchase mushrooms and markets them while others are only interested in production. It was not accidental that in the Netherlands a co-operate compost centre was established in 1953. This organization with the surrounding farms proved to be equal to rivals and is still in operation. The compost farm in a certain growing region has the sole task to provide growers with quality compost continuously at a reasonable price. The actual situation in Hungary is not uniform. There is only one farm to make compost exclusively, it also re-buys mushrooms and export them.

To parry quality problems manifested later in growing compost farmers should indicate the most **important parameters** (water content, pH, C:N ratio, total N, etc.) on a label and inform the growers of them.

2. The protection of **environment raises 3 important** questions: **air-pollution caused** by compost farms, **introduction of integrated production** and **re-utilization of spent compost**.

In some countries as well as in some parts of Hungary strict rules concerning **environment protection** and **air pollution** are accepted and they can and do limit activities in „central” compost farms. The Netherlands, the leading country in Agaricus production, can be mentioned as example. They were forced to work out the „indoor composting” method in order to minimize air pollution. Our compost farms are heavily encumbered with supplemental investments if they want to meet requirements.

It will be indispensable to **introduce integrated mushroom growing techniques** in Hungary. In some countries (e.g. USA) it is general practice. In countries of the EU a rational use of chemicals is gaining ground.

While working out the technology for the integrated mushroom cultivation I made a list of the most important pests and released chemicals to control them.

In an integrated mushroom production growing conditions are the firsts **to be determined** -in this case the **chemicals to be applied** - and then a well-organized **control system** must be found. **Trademarks** should be introduced. They ought to be patented and placed visibly on covers. Trademarks can call buyers, attention to goods coming from integrated production. Integrated production can also mean higher costs or lower yield which can result in higher prices. The State support granted to integrate mushroom growers would, no doubt, promote the spread of the rational use of chemicals.

The problem of **spent compost** must also be solved. In Hungary about **200 000 tons Agaricus compost** were produced in **2000**. Spent compost comes up to the same quantity. This problem cannot be avoided if we want to increase production.

Used up polyethylene bags mean serious pollution problems. According to my calculations 5000 tons/year polluted polyethylene bags accumulate in Agaricus production only.

3. **No quality standards** have been introduced yet for **fresh mushrooms**, not even in EU countries. At present only a recommendation for Agaricus is in use. Our fresh mushroom exporters are able to fully satisfy these demands. To my knowledge no standards for Pleurotus are available in the EU, in Hungary, however, regulations concerning Pleurotus quality have been worked out and also introduced. In my opinion fresh mushroom exporters will soon be obliged to accept the **HACCP standard**. I should advise to begin with its elaboration.

4. The consumption of fresh vegetables and fruit is increasing. Mushroom are no exceptions. **In Hungary 50 % of fresh mushrooms** are sold through **warehouses chains**. The importance of the wholesale market in Budapest is decreasing.

Warehouses chains expect round the year supply of equal quality but different quantity. In the future warehouse chains will prefer growers who can guarantee a continuous supply of large quantities delivered in small packages (200 g, 500 g) as required by customers. Only very big farms can comply with such demands. Smaller farms must join forces.

Fresh mushroom have been qualified for size, colour and cleanness as customers mostly buy by sight. We must be prepared, however, that in the near future sophisticated customers abroad, but on home market, too, will prefer quite other quality aspects, namely the **solids content of mushrooms**, that is, the inner value. Hungarian mushrooms are already able to satisfy such high demands.

It is a very bad strategy on part of Hungarian growers to try to invade export markets by reducing market prices. We must not forget that in most parts of the EU modern growing capacities are available and mushrooms will be produced even at the price of lower income. Poland also belongs to these countries. It is our first rival on German and Austrian markets due also to privileges granted by the Union.

Exporters and growers cannot avoid a **close co-operation**. A Product Organization (PO) ought to be established. The EU will also support its establishment, activity and conditions. There is no any mushroom PO in Hungary yet.

Home markets would deserve special attention. Mushroom consumption/person should be increased. There are considerable reserves in this respect. **Consumers at home should be offered firsts quality goods**. At the turn of the millennium no difference between home and export quality should be allowed.

It is inadmissible that beginning from supermarkets down to small market stalls nobody knows how to store, handle and sell fresh mushrooms properly. We ought to be more inventive in marketing, distributing goods (everywhere in the country) and producing new, kitchen-ready goods. Relations ought to be maintained with customers as the majority of them only knows the cultivated mushroom, Agaricus, and mushroom dishes are unvaried. If they got acquainted with oyster mushrooms or shiitake they might be encouraged to consume more. By propagating healthy diet mushroom consumption could be increased.

Neighbour countries could be supplied with fresh mushrooms even at the cost of stopping the export of spawned and III. phase composts.

Authorities should get induced to impose heavy-duty taxes on Chinese canned mushrooms, which are produced at extremely low costs.

5. Everybody knows that first quality mushrooms can only be harvested by hand. Attempts have been made to use machines without much success. If 70 000 tons mushrooms are to be grown by 2010, numerous, well-trained workers are needed. **Mushroom production creates new work places.**

The government program follows the SAPARD program of the EU and wants to establish mushroom production in underdeveloped regions recommending it to family farms.

6. In **Pleurotus growing** the building of, at least, one modern substrate farm would be the first important step. With 5-7 000 tons/year substrate production 1 000-1 400 tons mushroom bunches or 750-1050 tons leafy mushrooms could be harvested. There is a sound demand for them on West-European markets. For the sake of quality more climatized tents ought to be built and yield increased.

In **shiitake cultivation** substrate production is not reliable enough and growing technologies are not fully worked out. Other mushrooms in demand on markets would also deserve attention.

7. Education is as important as any innovation in technology or equipment. Mushroom production, like any other trade, has its own special technological requirements. Some growers are rather irresolute in this matter. The profession has to face a serious problem: the lack of interest from the part of young people. **Education must be improved if we want a quality-centric, cost-sensitive mushroom production.**

Under education I mean, besides school systems, special courses, training of skilled workers, managers, perhaps, special postgraduate expert training.

Mushroom research was rather neglected in the past. Steps should be taken to improve the situation.

The competitive of Hungarian mushrooms depends on our efforts to realize a modern, efficient, first quality production if we want to harvest 70 000 tons mushrooms by 2010.