

Bosnia and Herzegovina

# DEVELOPMENT OF MUSHROOM SECTOR,

## SUSTAINABLE AND INCLUSIVE MARKET





**Prepared by:** 

Professor Nezir Tanović, PhD Amela Ćosović - Medić



Bosnia and Herzegovina

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## SUSTAINABLE AND INCLUSIVE MARKET

- Activity Mapping
- Strategic Commitments to Mushroom Cultivation, Sustainable Collection, EU Export Potential
- Assessment of Environmental and Social Aspects

We strongly believe that this publication will serve as guidance to all of its users within the mycology sector and help them to identify inter-dependence with nature, where Nature will be truly preserved, and wisely managed by its users who by doing so will achieve economic, environmental and health-related benefits.

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## PREFACE

This study is the result of an attempt to give the mushroom-growing sector a prominent position and emphasize the possibility of developing sustainable, economic projects, especially in the rural areas of BIH. The study results from the joint work by a great number of wild fungi collectors and mushroom farmers who raise cultivated varieties of fungi, representatives of academic and professional services and from numerous rounds of consultation at different levels. Valuable support to the study's design and final shaping was unselfishly provided by the UNDP's Project Manager Amela Ćosović-Medić.

While preparing for the development of this study, numerous consultations and discussions took place, involving close to 100 representatives of various interest groups in the sector of mushroom growing and collection, who provided useful advice and guidance to achieve the goals and make arrangements contributing to the improvement of the sector and creating the possibility for its becoming one of the directions of the future engagement and sustainability in the regions known for difficult economic conditions. In the recent past, this sector has, unfortunately, been only encouraged without any incentives though, which is why its transformation toward progress and sustainability is partly blocked. It is hoped that this study will create the climate and conditions necessary for development projects in this area, motivate the rural population towards the possibility for an increased and sustainable collection and in particular, cultivation of mushrooms.

The task of the study is to propose a vision for the sector development with valid arguments in support of its acceptance and the proposal for specific measures and the possibility for its application in a broader production practice. These goals can be attained successfully only if the appropriate climate is created for the minimum conditions in entrepreneurial activities in the mushroom sector, for which the responsible institutions have not yet found the appropriate arrangements. An increased and more diverse mushroom production is slowed down. There are difficulties, first of all, because of an unregulated market and the lack of knowledge about many factors which affect a very sensitive production of the variety of fungi. Attempts to increase the growth of diverse types of fungi, especially in rural areas of BIH are important insomuch as they increase the real chance for this production to become sustainable, labour-intensive, profitable and export-oriented. With a well-devised concept of organisation, production and partial treatment and processing of mushrooms, and links with foreign markets, growing mushrooms can be a lucrative business as it brings in substantial profit that all those involved in the production chain and trade can be satisfied with.

Although the study focuses on exploring the possibilities and prospects within the various market aspects of cultivated and collected mushrooms, comparisons have been made to some extent also with wild mushroom sector given that both aspects form an unbreakable bond, especially in the food-processing area and the market.

The study needs to serve as an argument for a considerable number of people, especially in rural areas of BIH, to explore the possibilities for new investment enterprises and also to activate unused facilities (cellars, sheds, garages, stables, green-houses, etc.) as well as diverse plants for growing not only mushrooms but also other types of fungi for domestic and foreign markets, and for self-sustaining employment. Of course, the study points at the measures and procedures for sustainable mushroom collection with an emphasis on: assessment of environmental and social aspects, mapping of activities and sustainable and inclusive market.

## 2. Vision And Tasks Of The Sector

#### 2.1. Development Vision

UNDP's initiative and vision to launch some more important activities on the within the process of growing and collecting mushrooms and developing an inclusive and sustainable market can be an objective formula for mobilizing a significant portion of the rural population and as such, it is a realistic and absolutely feasible. In fact, the study should define also a whole series of issues within this sector, primarily, the possibilities for a more economic and more sustainable collection of wild, economically important and especially cultivated mushrooms, the market, a regulatory framework, environmental and social sustainability, roles and responsibilities of interest groups, which are the necessary conditions for improvements, and a profitable and sustainable sector. However, there are no simple solutions which would create a business formula on a sustainable basis. In fact, that is the process of a gradual change (transformation) which includes a series of supplementing interventions by a series of interest groups, each of which should make a contribution to the long-term goal of sustainable industry. Bearing in mind frequently conflicting interests of the various interest groups, a coordinating role is necessary in both collecting wild mushrooms and growing, including processors and traders. The focus in the mushroom sector is the therefore coordination of the three mutually linked functions: analysis of all the information related to this sector; balancing of different interests, and the implementation of agreements and adopted goals.

The tasks of the sector revitalization processes:

- To transform it structurally as per an increase in the number of cultivated mushrooms;
- *To increase productivity and employ rural population;*
- To collect wild mushrooms economically and sustainably.

In the shortest term possible, the vision for the sector development can be defined with the aspiration to turn the underdeveloped sector of today into the environment which will be

- *Rural-friendly*;
- Sustainable in terms of mushroom collection and cultivation;
- Technically and technologically modern,
- Environmentally acceptable.

## 2.2. Tasks within the Sector

The mushroom growth and collection, from the current level what is expected from it:

- To provide through the collection procedures and growth measures a product (mushroom) which will be accepted by the producer in the country and abroad,
- To ensure the level of profitability and sustainability,
- To employ a considerable size of the rural population,
- To transform the current collection practice and the mushroom production structure and to take it to the next level, the revitalization process.

## 3. Approaches To The Development

#### 3.1. Study Development Methodology

The improvement and transformation of the overall mushroom sector into a sustainable collection and production practice is achievable through clear development strategy. Preparation of this study is aiming to precisely outline such needs. This sector is among the least regulated areas of agriculture, which is why there is a whole series of questions about it:

- how a certain number of people living in rural areas can be encouraged to grow mushrooms (employment),
- how they can be technologically equipped for mushroom production,
- how stable (sustainable) production can be achieved,
- how elements of competitiveness can be found on foreign markets,
- how a broader mushroom product range can be ensured,
- how a single BIH and foreign market can be established,
- *How interest-based organisations of people with a common purpose can be organised (associations, etc.).*

## 3.2. Starting Points and Principles of Sector Development

The mushroom sector is considered to be an area without established links with other branches of agriculture, although it may have a whole series of incoming and outgoing interactions with numerous entities, and the food processing industry in particular. Given the importance of a role it can play in terms of employment in rural areas, this sector should become sustainable, which is why improved competitiveness and market principles are the key targets of its development. In practice, this should be achieved through the following:

- By creating macro-environmental conditions and an increased development support for the sector,
- With the strength of the micro-marketing conduct, improvement and diversity of production, technical and technological improvement of production and processing, finding a market (overseas market in particular), improvement of technical knowledge and skills.

In both production and collection of wild mushrooms it is necessary to support only the segment which relies on the established market access and leave all decisions to the discretion of producers as to which type of mushroom will be produced or collected and the size of production/collection. The interest-based networking (the future association) should provide sufficient information on their plans on production to ensure these are the most appropriate and quality decisions. The market orientation is achievable only if the sector becomes competitive through, inter alia:

- An increased participation in the mushroom production, especially in a bigger and more diverse production structure,
- Introduction of a modern technical and technological solutions to the production,
- Accepting marketing as a business conduct.

#### 3.3. Study Development Scenario Selection

Along with the accomplishment of the above-mentioned assumptions, the mushroom sector may objectively become one of the most relevant participants in the production and in employment of rural population in BIH. This can be achieved through a combination of the following factors:

- Sustainable collection and production within the existing and establishment of new production facilities,
- Production shaped to fit the market and yield profit (the most important factor).

These factors are not technical in nature; rather, it is about the decisions which have economic and social consequences for the rural areas. There are two possible scenarios in the study for the proposed revitalization of this sector:

Mushroom production with a **fully free market** and the presence of the state only in the price protection when excessive and dumping import prices cause major damages to domestic production (it is necessary to comply with the signed Free Trade Agreements, and to require special privileges for the countries in transition, such as BiH). The other scenario is the **free market**, with an ensured development of the sector and creation of the competitive business environment, production and collection process. These interests are mirrored in the production and cultural environment, motivation of population to live in rural villages, etc.

On the basis of the above scenarios, it can conclude that the latter scenario has better prospects because of: encouraging rural development with active micro and macro marketing, focusing on a broader range of mushroom production, on a higher quality, higher budget allocation for support, and for export premiums in particular, and a higher employment.

## 4. Reasons For The Sector Development

#### 4.1. Reasons to Focus on Development

The sector of mushroom growth and collection is one of the least regulated areas of agriculture, which is why a whole series of questions are raised about it:

- How rural population can be encouraged to engage more in collecting both wild and cultivated mushrooms,
- How they can be redirected to expand both the structure and volume of production,
- How the employment of different gender and age groups, including those with a limited physical capability among rural population, can be increased,
- How domestic and foreign markets can be established.

## 4.2. Sustainable Industry in the Sector

Sustainable industry in the sector is important for making profit from collecting and growing mushrooms. In fact, it implies:

- Reduction of poverty and injustice (social sustainability),
- *Regeneration-protection of biodiversity and the environmental resource base (environmental sustainability).*

Although, in principle, social and environmental sustainability are treated separately, these can be also considered jointly. Social sustainability refers to producers and collectors of mushrooms and other secondary forest products while certainty, sustainability and profit for a great number of people who live in rural areas depend precisely on sustainable use of resources. Social structures of the rural population are largely related to the use of natural resources, and, among other things, to mushroom collection. Today, 50% of rural population in BiH live below the poverty line; around 60% of population aged above 18 are unemployed.

## 4.3. Analysis of Profit and Trade Relations

The mushroom growth includes a small share of rural population; button mushrooms are grown mainly close to or directly within urban areas, where there is also negligent number of oyster mushroom farmers. The mushroom collection sector includes the following people: 15% of young collectors, 55% of middle-aged people, mainly women, and 30% of elderly collectors. All groups of collectors (domicile population, returnees and refugees) live under extremely difficult conditions.

Collection of mushroom and medicinal herb is the major source of income for 60% of collectors; for 30% of collectors, it is 50% of their income; and 10% of rural population are less dependent on these resources. Mushroom growers and collectors are among the poorest groups of people. The income earned from mushroom growing and collections are often inconsistent. It is well known that a considerable number of mushroom collectors and growers have a very low level of knowledge.

Six to seven economically important types of mushrooms are collected and only one type of mushroom is predominantly grown (button mushroom and far less the oyster mushroom). For many collectors and growers, there is no fair and justified price distribution. Selling prices are mainly in favour of the wholesale suppliers, and especially for the purposes of the retail network. The fairness of trade relations in the mushroom growing and collection does not refer only to the price. Other factors which should be taken into consideration include distribution of risk, instant or advance payment, costs of transportation, training etc.

The overall situation on the market has a special weight. The mushroom growing market is completely unregulated. Numerous mushroom growers have reduced or given up mushroom farms as a result of the collapse of economy in BiH, the non-organised market and low prices, while the collectors of wild mushrooms often do that to meet the minimum living standards.

It is true of the mushroom growers that they focus solely on growing button mushrooms and far less on oyster mushrooms (that is, unvaried supply), while there is low demand, potentially excessive supply, and the emphasis on price rather than on quality. In terms of wild mushrooms, combined with poverty and helplessness, most of mushroom collectors demand lower prices. The profit of both mushroom growers and collectors can increase if:

- Participation in the value chain is increased and if growers and collectors are given a larger proportion of the value,
- The price is increased through added value,
- The market is provided for the sale of a larger number of products and an increased diversity and if direct trade relations are established (the most important segment),
- Fair trade initiative is launched.

## 5. Achieved Level Of Development

## 5.1. Volume and Structure of Production of Cultivated Mushrooms

The wild mushroom production and collection is a systemic part of the overall agricultural activities, which is why the situation especially in mushroom growth (cultivation) is reflected through the entire environment. It is important to mention that no social or business environment has been created yet for this sector. Despite some individual successes, these are not sufficient for the overall sector to succeed or for building a single business and economic environment or a single market, nor has there been any progress in the entrepreneurial climate.

The mushroom sector continues to face numerous problems and has not shown yet a clear vision of development; rather, it is suffering from the crises of stagnation and indecisiveness in general. Caught within this poorly devised concept, and especially on the almost complete dependence on import of raw materials (compost and casing soil), unregulated market, low level of knowledge, insufficient support, this production has stagnated over the last several years. Unlike this situation, there are positive examples of mushroom growing businesses ("Bio–Šamp, Šije – Tešanj) which can compete with the best European companies.

The result of this situation emits the warning signals through:

- Stagnation in the mushroom growing sector and a call for transformation,
- Strengthening of development actions as per volume and structure of mushroom production,
- Stagnation in technical and technological terms,
- Dehumanisation and devastation of rural areas and a massive rural migration of young people.

| No. | F BiH       |                              | Brčko<br>District            | Republi                      | ka Srpska                    |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|-----|-------------|------------------------------|------------------------------|------------------------------|------------------------------|---------------------------|------------------------------|------------------------------|-----|-----|-----|-----|-----|-----|----|--|--|
|     |             |                              | Т                            | ype of mushro                | om                           |                           | To                           | tal                          |     |     |     |     |     |     |    |  |  |
|     | Canton      | Button<br>mushroom<br>(tons) | Oyster<br>mushroom<br>(tons) | Button<br>mushroom<br>(tons) | Button<br>mushroom<br>(tons) | Oyster mushroom<br>(tons) | Button<br>mushroom<br>(tons) | Oyster<br>mushroom<br>(tons) |     |     |     |     |     |     |    |  |  |
| 1   | Sarajevo    | 120                          | 14                           | - 110 830                    |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | BPK         | 12                           | 0                            |                              | - 110                        |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | Canton 10   | 60                           | 6                            |                              |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | ZDK         | 480                          | 7                            |                              |                              | 110                       | 110                          | 110                          | 110 | 110 | 110 | 110 | 110 | 830 | 44 |  |  |
|     | TZK         | 160                          | 8                            |                              |                              | 050                       |                              |                              |     |     |     |     |     |     |    |  |  |
|     | USK         | 110                          | 6                            |                              |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | HNK         | 130                          | 0                            |                              |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | Posavina    | 30                           | 0                            |                              |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     |             |                              |                              |                              |                              |                           |                              |                              |     |     |     |     |     |     |    |  |  |
|     | Grand Total | 1102                         | 48                           | 110                          | 830                          | 44                        | 2042                         | 92                           |     |     |     |     |     |     |    |  |  |

Table 1 Volume of production (cultivation) of mushrooms in BiH in 2010



Graph 1. Mushroom production volume in 2010

#### 5.2. Available Capacities for Mushroom Production, Treatment and Processing

The facilities and the mushroom production are mutually dependent and constitute an inseparable reproduction structure. In the context of production facilities for the volume of produced mushrooms, the following is defined:

| • | Mushroom growing facilities          | 40%, |
|---|--------------------------------------|------|
| • | Greenhouses for growing mushrooms    | 20%, |
| • | Inadequate and improvised facilities | 40%. |

Greenhouse mushroom production at Šije-Tešanj(,,Bio-Šamp" is a single leader in mushroom production, a significant portion of the overall oyster mushroom production, and of initial shiitake mushroom production

**Treatment** and processing of mushrooms has been reduced to negligible levels. In fact, there is no serious company with mushroom processing as a primary activity. Nearly 100% of different processed mushroom products that appear on our market are imported from abroad. Drying of mushrooms, partly by natural means, party in special drying facilities dominate within the existing production facilities. This treatment procedure is linked to hyper production. Such mushrooms are most often sold to catering industry: pizza houses, restaurants and others.

#### 5.3. Internal Market Environment

The mushroom production in a certain period of the year provides sufficient quantities for the population own needs. However, due to a higher percentage (40%) of inadequate production facilities (lack of automated air conditioning system, heat regime, humidity 0%); the production is seasonal, and thus unequal throughout a year.

During those production gaps mushrooms are imported, though sporadically and in smaller amounts, from the neighbouring countries. On the other hand, with favourable agro ecological conditions of the environment, inadequate facilities are used for mushroom production during the hyper production season. This problem is solved mainly by drying mushrooms for catering industry.

## 6. Proposed Measures For Improving The Sector

## 6.1. General Principles

As it is defined, the revitalization of the sector may play an important role in creating a living environment in rural areas. It can be recognized only as one and never as the only stimulus that drives life in a village, which includes: creation of a spatial demographic picture in the rural-urban relation. Starting from the facts that the progress in mushroom production has been evident over the last several years, the future development of this sector should be based on the following principles:

• To adapt the existing inadequate and unused facilities in rural households which show interest in mushroom production,

A considerable number of non-utilised facilities in rural areas can be adapted for the oyster mushroom production in particular.

• To direct mushroom production in an investment –like approach towards greenhouse structures and a largely increased share of oyster and shiitake mushroom production within the overall production structure.

Examples of a successful production in a greenhouse environment of "Bio Šamp" Šije – Tešanj indicate how production in such facilities has a big advantage over the purpose built structures. One of the reasons is the possibility for an organic-ecological-biological mushroom production (disinfection with steam vapour only), which is a far cheaper investment.

• To rehabilitate and modernise domestic production of compost and casing soil.

The basic raw materials for production of compost and casing soil are the substances imported from: Hungary, Italy, Serbia and other neighbouring countries. The compost production in Gradačac, with minor investments, can meet the producers' needs, quality and demands. Production of compost for oyster mushroom growing should be based on domestic resources (wheat, buckwheat straw and maize stalks).

• To follow technically and technologically the European achievements and be competitive in the European market in terms and quality and price,

The European market, which is quite demanding and subtle, requires quality, a certified product, obeying contractual agreements. Such conditions require technical and technological adaptation of production to the European standards.

• To introduce stimulating measures, especially export premiums,

In some cantons in FBiH, within incentive programmes for agriculture, mushroom production is stimulated through one ton of imported compost. It is necessary to be strategically oriented to obtaining recourse loans, a longer grace period and repayment period, exemption from customs duties for imported equipment and raw materials.

• To ensure through professional associations the protection of interests of mushroom producers and collectors.

#### 6.2. Production Possibilities

#### 6.2.1. Cultivated Mushrooms

In terms of the volume, structure and value of mushroom production, BiH is lagging far behind other countries in the region. The development of this sector will increase employment opportunities for rural population. Still, the future mushroom growers will base their production-related decisions on the messages from foreign markets and on incentives and other measures that the state will take to support the mushroom production sector.

Regardless of great mushroom production possibilities, in particular the possibilities for the production of oyster and shiitake mushrooms,<sup>1</sup> the following outlines the main, sustainable production models in rural areas:

• Combined (mixed) market - commercial production

This production would include sustainable procedures and technological processes. Production which is harmonized with the resource specific for individual households, production which is expected to make profit at the level of an average salary in the country. Such a model of production implies also cattle breeding and fruit and vegetable and medicinal herb growing, bee-keeping and mushroom growing, etc.

• Specialized production (mushroom production)

This production implies only market-commercial, sustainable production of mushrooms, while other forms of production are secondary.

The authors of this study believe that both systems need to be improved scientifically and professionally and acceptable production models should be sought for individual households and regions. The mushroom production in BiH has doubled over the last few years. The production volume has not been largely affected by an increased involvement of individuals and legal entities in production; rather, it has been driven by an increased production volume in the already existing production facilities. A significant increase of the overall production by 25% comes from a single producer ("Bio-Šamp"- Šije – Tešanj).

The current relatively smaller mushroom production volume - the volume of production of oyster and shiitake mushrooms in particular, in regard to the future needs of the domestic and foreign markets should be improved through the above-mentioned measures. A stronger preference and support should be given to the oyster and shiitake mushroom growing since it will be giving more profit in the near future, will require less investments and production conditions which are similar to natural conditions, with less imported input to production, and will ensure a higher profit to producers.

<sup>&</sup>lt;sup>1</sup> Names of mushrooms: buttom mushroom (*Agaricius bisporus*), oyster mushroom (*Pleurotus sapidus*), Shiitake (*Lentinula edodes*).

|      | FBiH     |          |          | Brčko District |          |          | Republika Srpska |          |          |
|------|----------|----------|----------|----------------|----------|----------|------------------|----------|----------|
| God. | Button   | Oyster   | Shiitake | Button         | Oyster   | Shiitake | Button           | Oyster   | Shiitake |
|      | mushroom | mushroom | (t)      | mushroom       | mushroom | (t)      | mushroom         | mushroom | (t)      |
|      | (t)      | (t)      |          | (t)            | (t)      |          | (t)              | (t)      |          |
| 2010 | 1102     | 48       | 0        | 110            | 0        | 0        | 830              | 44       | 0        |
| 2011 | 1280     | 65       | 12       | 116            | 5        | 2        | 900              | 55       | 8        |
| 2012 | 1310     | 90       | 20       | 125            | 12       | 4        | 1050             | 75       | 18       |
| 2013 | 1380     | 130      | 25       | 135            | 20       | 5        | 1200             | 110      | 22       |
| 2014 | 1450     | 160      | 28       | 150            | 30       | 6        | 1350             | 150      | 24       |
| 2015 | 1500     | 200      | 30       | 165            | 32       | 8        | 1500             | 190      | 26       |

 Table 2. Projection of mushroom production (until 2015)
 Image: Comparison of the second s



Graph 2. Projection of mushroom production (until 2015)

#### 6.2.2. Wild Mushrooms

Mushrooms from natural populations (wild) occupy an important place in economy and food. Diversity and quantity of mushrooms in Bosnia and Herzegovina are very rich. When exploring the possibilities, the overall spread and richness, for all participants in the chain (collectors, wholesale and retail sale) the mushroom collection is a labour-intensive, highly accumulative, export-oriented and generally profitable activity.

A great number of diverse mushrooms and other wild edibles are present across the BiH territory, while a certain number of them are a challenge which has to be controlled and used rationally. The collection of a smaller number of economically important mushrooms dominate in BiH; those are primarily **bolete** (*Boletus edulis*); **morel** (*Morchella conica*); **chanterelle** (*Cantharellus cibarius*); **Caesar's mushroom** (*Amanita caesarea*); **black trumpet** (*Craterellus cornucopioides*), **saffron milk cup** (*Lactarius deliciosus*). The export of mushrooms from natural populations is growing every year.

According to the data (not fully processed) it can be expected that export of mushrooms in 2010 will be significantly bigger than it was in the previous years.

|     |                                    | 2008    |           | 2009    |           |
|-----|------------------------------------|---------|-----------|---------|-----------|
| No. | Various structures of<br>mushrooms | Amount  | Value     | Amount  | Value     |
| 1.  | Fresh mushrooms                    | 153.748 | 2.380.471 | 273.851 | 3.155.137 |
| 2.  | Frozen mushrooms                   | 96.645  | 1.176.276 | 262.527 | 2.342.389 |
| 3.  | Canned mushrooms                   | 46.506  | 536.572   | 64.633  | 471.528   |
| 4.  | Dried mushrooms                    | 54.817  | 2.770.092 | 91.187  | 3.760.189 |
|     | TOTAL                              |         |           |         |           |
|     |                                    | 351.726 | 6.863.411 | 692.198 | 9.729.243 |

#### Table 3. Export of different structures of mushroom products

Import of fresh mushrooms and mushrooms at different processing stages shows a mild increase every year. Dried mushrooms are most commonly imported as a result of firm partnership and extreme demand.

|     |                  | 2008   |         | 2009   |         |  |
|-----|------------------|--------|---------|--------|---------|--|
| No. | Type of mushroom | Amount | Value   | Amount | Value   |  |
| 1.  | Fresh mushrooms  | 1.153  | 2.681   | 2.029  | 6.836   |  |
| 2.  | Frozen mushrooms | 4.451  | 9.950   | 2.910  | 24.364  |  |
| 3.  | Canned mushrooms | 17.407 | 32.095  | 12.258 | 73.338  |  |
| 4.  | Dried mushrooms  | 33.361 | 631.819 | 27.690 | 690.192 |  |
|     | TOTAL            |        |         |        |         |  |
|     |                  | 56.372 | 676.545 | 44.887 | 794.730 |  |

Table 4. Import of different structures of mushroom products

#### 6.2.3. Models and Economic Parameters of Cultivated Plants

All indicators are in favour of the fact that there is a gradual increase in the mushroom production volume. The volume refers not only to the production of button mushrooms, but also to production of oyster and shiitake mushrooms. Below are presented different models for a sustainable mushroom cultivation, for the purpose of analysis of sustainable mushroom cultivation and reliable economic parameters.

#### **Button mushroom production models**

<u>Model 1. Production in a partly adequate facility (facility without an air-conditioning chamber)</u>

## Space of $100 \text{ m}^2$ one (1) and three (3) cycles

| Costs:                                     |              |
|--------------------------------------------|--------------|
| Compost 600 bags                           | 3.900,00 BAM |
| Casing soil 134 bags                       | 1.050,00 BAM |
| Protection                                 | 80,00 BAM    |
| Energy                                     | 150,00 BAM   |
| Labour force                               | 220,00 BAM   |
| Packing material and packaging             | 210,00 BAM   |
| Total costs                                | 5.620,00 BAM |
| Revenues:                                  |              |
| Button mushrooms 2.300 kg x 3,70           | 8.510,00 BAM |
| Revenue 8.510,00 – costs 5.620,00 = PROFIT | 2.890,00 BAM |
| THREE CYCLES X 2. 890,00                   | 8.670,00 BAM |

Explanation: it is not possible to produce more than three cycles of button mushrooms in the facilities which are not fully adequate for the production process (specific temperature conditions, air-conditioning and humidity).

# Model 2. Production under adequate production conditions (facilities with air-conditioning chambers)

## Space of $100 m^2$ one (1) cycle

| Six (6) cycles x 4.370           | 26.220,00 BAM |
|----------------------------------|---------------|
| Profit (Revenue – costs I cycle) | 4. 370,00 BAM |
| Revenue (2.700 kg)               | 9.900,00 BAM  |
| Costs                            | 5.620,00 BAM  |

Explanation: Under adequate conditions it is possible to produce five cycles. However, if it is Italian incubated compost, the mushroom production cycle is reduced from 65 to 45 days, and it is possible to produce seven cycles.

#### Model 3. Suitable for mixed production in rural areas

## Production in a partly adequate facility of $30 \text{ m}^2$

#### **Costs:**

| THREE CYCLES X 1.183                       | 3.549,00 BAM |
|--------------------------------------------|--------------|
| Revenue 3.700,00 – costs 2.517,00 = PROFIT | 1.183,00 BAM |
| <b>Revenue</b> 1.000 kg x 3,70             | 3.700,00 BAM |
| Costs                                      | 2.517,00 BAM |
| Packing material and packaging             | 140,00 BAM   |
| Labour force                               | 180,00 BAM   |
| Energy                                     | 110,00 BAM   |
| Protection                                 | 50,00 BAM    |
| Casing soil 55 bags                        | 412,00 BAM   |
| Compost 250 bags                           | 1.625,00 BAM |

Thus, the model is quite useful for mixed market production which implies revenues also from other agrarian products. Three cycles are possible as a result of the illustrated model which is not fully adapted to the mushroom production (partly adequate facilities).

## Models of production of oyster and shiitake mushrooms

The production of oyster and shiitake mushrooms is much simpler than the production of button mushrooms. The oyster and shiitake mushrooms prefer cultivation which is close to agro ecological conditions of the environment. The advantages, in comparison to button mushrooms, are the raw material (compost) which is in the rural production areas wheat by-product (wheat and buckwheat straw and maize stalks, etc.). The production price of oyster mushrooms, provided that the producer is using the wheat substrate, is estimated at:

- 1,20 BAM for oyster mushroom
- 2,0 KM for shiitake

The production price of one ton of substrate is 180 BAM. One tone of substrate can provide 300 kg of oyster mushrooms and slightly less shiitake. This means that shiitake mushroom requires nearly the same production costs while its price is eight (8) times as that of oyster mushroom. One tone of substrate requires 400 kg of straw. One kilogram of substrate material costs 0,12 KM, or 48 BAM for one tone. 250-300 litres of mycelium are used per one tone. One litre of mycelium costs 1 BAM if it is produced in a handy laboratory.

In the near future, the mushroom production structure will be expanded to include the cultivation of: tuber/truffle (*Tuber sp.*), wine cap stropharia or king stropharia (*Stapharia rugosoannulata*), velvet foot (*Flammulina velutipes*), shaggy mane (*Coprinus comatus*), morel (*Morchella conoca*), black poplar (*Agrocybe aegerita*), Jew's ear (*Auricularia auricula judae*), hedgehog mushroom (*Herecium erinaceus*).

## 6.2.4. Models and economic parameters for wild mushrooms.

The amount of collected mushrooms is related to the following factors:

- Agro ecological conditions as key factors for the appearance and a wide distribution in nature.
- The price of fresh and dried mushrooms.
- Regulated and certain purchase.

| Name of mushroom                                    | Hours spent per | Unit of measure | Price in | Total BAM |
|-----------------------------------------------------|-----------------|-----------------|----------|-----------|
|                                                     | year            | kg              | BAM      |           |
| Edible bolete (Boletus edulis)                      | 100             | 80              | 7,00     | 560,00    |
| Morel (Morchella conica)                            | 100             | 40              | 12       | 480,00    |
| <b>Chanterelle</b> ( <i>Cantharellus cibarius</i> ) | 100             | 200             | 2,5      | 500,00    |
| <b>Caesar's mushroom</b> ( Amanita caesarea)        | 100             | 80              | 6        | 480,00    |
| Black trumpet (Craterellus cor.)                    | 100             | 300             | 1        | 300,00    |
| Saffron milk cup (Lactarius deliciosus)             | 100             | 300             | 1        | 300,00    |
| TOTAL                                               | 600             | 1.000           |          | 2.620,00  |

#### Table 5. Calculated value of mushroom collection

Explanation: within a total of 600 hours (75 days) one collector of an average annual mushroom yield, in an objective growth dynamics (bolete 30-40 days; morel 30-40 days; chanterelle 30-40 days; Caesar's mushroom 20 days; black trumpet 15 days; saffron milk cup 30 days of appearance in a year) can make BAM 2,620.00. The revenues are increased if the number of working hours is increased and if the family household gets involved in the mushroom collection.

6.3. Minimum equipment necessary for the production of button, oyster and shiitake mushrooms

## Model for the existing less adequate facility of 50 m<sup>2</sup>

|    | Name of equipment and packaging      | Quantity/pieces      | Amount in BAM |
|----|--------------------------------------|----------------------|---------------|
| 1  | Cutter                               | 1                    | 1.800.00      |
| 2  | Hydro isolation coat                 | Set                  | 800,00        |
| 3  | Hot water device                     | 1                    | 1.000,00      |
| 4  | Ventilation with weighing instrument | 1 set                | 2.000,00      |
| 5  | Block-board                          | Set                  | 1.200,00      |
| 6  | Lattice floor                        | 1                    | 1.600,00      |
| 7  | Dozers                               | Set                  | 2.500,00      |
| 8  | Decimal scales                       | 1                    | 600,00        |
| 9  | Prefabricated metal boards           | For 50m <sup>2</sup> | 2.800,00      |
| 10 | Styrofoam packaging                  | -                    | 800,00        |
|    | TOTAL                                |                      | 15.100,00     |

#### Table 6. Structure and volume of equipment and packaging for a less adequate facility.

Note: the model refers only to the adaptation of an inadequate space and only to the necessary equipment. The equipment does not include a substrate transporter or picking attachments for oyster and shiitake mushroom collection.

## 6.4. Equipment for treatment of wild mushrooms – purchaser

|    | Name of equipment                   | Quantity/pieces | Amount in BAM |
|----|-------------------------------------|-----------------|---------------|
| 1  | Cooling chamber 0 / - 20 °C 6 x 5m  | 1               | 18.000        |
| 2  | Decimal scales - 100 kg             | 1               | 600           |
| 3  | Electric mushroom cutter            | 1               | 2.400         |
| 4  | Drying chamber                      | 1               | 14.000        |
| 5  | Automatic scales for small packages | 1               | 1.500         |
| 6  | Welding devices for polythene bags  | 1               | 1.200         |
| 7  | Manual hydraulic forklift truck     | 2               | 1.800         |
| 8  | Wooden palettes 1.000 x 1.200       | 50              | 500           |
| 9  | Prefabricated metal boards – m      | 50              | 1.500         |
| 10 | Solid fuel boiler-house             | 1               | 8.000         |
| 11 | Hygrometer for dry mushrooms        | 1               | 1.600         |
| -  | TOTAL                               | •               | 51.000,00     |

Table 7. Structure and volume of equipment for treatment of wild mushrooms

## 6.5. Employment Aspects

According to the relevant budget data, it is possible to estimate the sustainability of and employment in and profit from the mushroom production, as follows:

- The model of a partly adequate space of 100 m<sup>2</sup> and three button mushroom growth cycles provides one (1) position and an annual earnings of BAM 8,670.00.
- The model of an adequate space of 100 m<sup>2</sup> and six button mushroom growth cycles provides three (3) positions an annual salary of BAM 26,220.00.
- The model of production in a partly adequate facility of 30 m<sup>2</sup> in three growth cycles corresponds to the market mixed production, with a profit of BAM 3,549.00 which, together with the profit of other productions, would be sustainable.
- The models of oyster and shiitake mushroom production are incomparably simpler and more profitable in comparison to the button mushroom production.
- The model of one collector of medicinal herbs with 75 working days (1,000 hours) shows the profit of BAM 2,620.00.



Graph. 3. Projected increase in employment in the mushroom growing sector in BiH

It is not possible to predict the employment growth in the wild mushroom collection since the volume and distribution of mushrooms are linked exclusively to agro ecological conditions (humidity, maximum and minimum temperature levels).

## 7. Wild Mushroom Habitats

Mushrooms grow within different habitats (locality of growth) and on different substrates (the surface or medium on which mushrooms grow) in all climate regions. BiH is known for a rich spectrum and a wide distribution of mushrooms as the country lies in a moderate northern zone, which is the richest in mushroom growth thanks to rich deciduous and coniferous forests, an extremely large number of plant species, diverse soil types and climate. Temperature, air humidity, vegetation and locality of growth, i.e. the quality of nutritious substrate are the key to the wild mushroom growth.

A special attention should be given to the mushrooms which grow in forests, as 80% of mushrooms grow near trees. For this reason, mushrooms should be sought in the forests, groves and thickets. This is why, mushroom collectors have to be able to recognize trees if they are to find and identify mushrooms more easily. The richest variety of mushrooms can be found around oak, beech, spruce, pine, fir, chestnut, birch, hornbeam, larch trees and alders. Some mushrooms grow only under some types of trees; others can grow next to many types of trees, some in deciduous forests, some in coniferous forests and some in mixed forests.

It has been noticed that deciduous forests are more fertile in spring and coniferous forests in autumn. Mixed deciduous-evergreen forests have more diverse mushroom growths than forests with one tree type. Scrub woods and underbushes especially those with creepers, tall grass, flowers and other low plants are unsuitable for mushrooms. The most suitable forests are those with not much stunted grass or moss, and mushrooms grow best also at the edge of forests where there is lighter. One group of mushrooms grow on live trees, dead remnants of trees, tree stumps, trunks of decaying trees or hidden roots, cones, leaves, pine-needle forest floor, or in a group of pine needles, etc.

Many mushrooms are found across pasture ground, fields, meadows and grazing land, especially on mountains, most commonly agarics' mushrooms, shaggymane mushrooms and common ink-caps, puffball, St. George's agarics, parasol mushrooms, wax cap mushrooms, tricholoma mushrooms, etc. Today meadows are often polluted with nitrates which destroyed the areas once rich in mushrooms, so that the best would be to pick mushrooms that grow in the fields' cultivated using natural organic manure instead of mineral fertilizers. Different types of soil are also important as some mushrooms grow only at the base of a tree, on a certain type of soil. Some mushrooms will grow around the base of a tree, from a certain type of soil only. Some mushrooms grow only from the ground feeding on humus, others in forested areas after fires or other burn areas; some on manure piles; or lonely in the sand; or from clay soil; some favour calcareous soil; or swampy ground.

After drought, mushrooms will not spring up across grasslands, meadows or forests immediately after the first rain has fallen down. The old saying, "they spread like mushrooms after a fresh spring rain" is true only of a few varieties, namely, button mushrooms and shaggymane mushrooms, since most of mushrooms need 10 to 15 days to sprout underground and only then spring up, and edible bolete need around 7 days. If some mushrooms sprout immediately after rain, that is the result of the rain from seven days before. Mushrooms need water for their fruit to grow and humidity levels are never too high for them. This is true for morels in particular. Where humidity is very high and when temperature ranges between +11 and +22° C, there are mushrooms everywhere. The best are found between the bouts of heavy rain and sunshine, when the soil vaporizes. However, during heavy rain falls, mushrooms are short-lived fruiting bodies as they quickly go mushy and mouldy and rotten. In such weather, mushroom gatherers should collect them more often than they usually do.

Most mushrooms grow best in light, which is the reason why they grow at the edge of forests and by roads. Some types of mushrooms need less light than others and grow deep in the forest; some, like the white button mushrooms, grow in complete darkness, and others, like truffle/tuber mushrooms, grow underground.

#### 7.1. Assessment of the Wild Mushroom Resource

A great variety of tall mushrooms grow in BIH. Around 200 types of edible mushrooms, around 60 types of poisonous and around 30 types of fatally poisonous mushrooms are known.

It is estimated that only 15-20% of the high potential of sustainable mushroom collection has been realised, which means that there is a possibility for an increased engagement of all structures and categories of the population in the mushroom collection sector. None of the above-mentioned economically important mushrooms is rare, risky or protected species of fungi.

| Туре                             | Economically | Allowed annual quantity for |
|----------------------------------|--------------|-----------------------------|
|                                  | important    | sustainable exploitation    |
| Edible bolete (Boletus edulis)   | *            | unlimited                   |
| Morel (Morchella conica)         | *            | unlimited                   |
| Chanterelle (Cantharellus        | *            | unlimited                   |
| cibarius)                        |              |                             |
| Caesar's mushroom (Amanita       | *            | unlimited                   |
| caesarea)                        |              |                             |
| Black trumpet (Craterellus cor.) | *            | unlimited                   |
| Saffron milk cup (Lactarius      | *            | unlimited                   |
| deliciosus)                      |              |                             |

#### Table 8. Assessment of the resource sustainability

## 7.2. Mushroom Collection Rules, Measures and Procedures

The approach to mushrooms has to be the most serious one, as any rush, lack of caution, haste and self-confidence may be fatal. Only one olive-green death-cup or the destroying angel can kill the whole family. People have been trying for a long time to find a method for distinguishing between edible and poisonous mushrooms. Such a method has never been identified.

The basic rule is that every mushroom needs to be identified properly and the gatherer has to be 100% certain that the mushroom is edible. If there is the slightest doubt, the best is not to touch the mushroom at all.

Young mushrooms, in an early stage of growth, are most dangerous even for mushroom experts as the characteristics that make them identifiable have not fully developed.

In order to be able to study mushrooms, one should know morphologic characteristics of some types, time and place of their growth, which is crucial for identification of mushrooms. In this approach to mushrooms, the methods of eliminating those characteristics which are not specific for a certain type have been used.

Some mushrooms grow only on a tree trunk or only at the base of a tree; some grow only in early spring, or in another season of a year, etc.

Some mushrooms are easily identifiable by the tiny spikes or leaves under the cap or small holes on the underside of the cap. Also other morphologic characteristics, such as flaky white scales on the cap, a ring (annulus) around the stem, or remnants of the veil left after the mushroom is ripe, the colour of the mushroom spores, etc., have to be carefully observed.

#### 7.3 Picking Mushrooms - Misconceptions

- Poisonous mushrooms blacken onions, parsley, silver coins or silver spoons; edible mushrooms do not change the colour of silver when boiled together.
- Poisonous mushrooms change the colour of water in which they are boiled; scarlet waxy cap (Hygrocybe punicea),
- Mushrooms that smell like flour are edible: autumn skullcap (Galerina marginata) does have a slight flour-like smell but is deadly poisonous. A deadly poisonous agaric (Entoloma lividum) has a flour-like smell especially when it is young, and is poisonous.
- All mushrooms that shoot out of the egg are poisonous: Caesar's Mushroom (Amanita caesarea) shoots out of the egg and is one of the best mushrooms,
- All spring mushrooms are edible: the fool's mushroom (Amanita verna) is deadly poisonous and the brain mushroom (Gyromitra esculenta), if eaten fresh, is poisonous; it is also poisonous when cooked if it is consumed often due to its cumulative effect. All autumn mushrooms are edible: the death cap (Amanita phalloides) is deadly poisonous,
- The mushrooms that grow on live trees are edible: the jack-o'-lantern mushroom (Omphalotus olearius) grows on trees; the wood-rotting fungi are poisonous, is another misconception,
- The mushrooms that grow near poisonous fungi or plants become poisonous: the real edible bolete (Boletus edulis), as a rule, appears together with the fly agaric (Amanita muscaria), and the salmon-coloured Lactarius salmonicolor grows near a very poisonous deadly nightshade herbaceous plant. The mushrooms have their hereditary traits and young poisonous mushrooms spring up from the poisonous spores, and young non-poisonous mushrooms grow from unopened spores. There are no other factors which could make a non-poisonous mushroom a poisonous one,

- Edible mushrooms can be distinguished from the poisonous ones by the change of colour when the mushroom is bruised or cut: many most delicious edible mushrooms (edible bolete) change colour when cut while the most poisonous mushroom, the fool's mushroom, is a deadly all-white mushroom which does not change colour,
- Toxicity of mushrooms disappears if the mushrooms are boiled in water mixed with a glass of vinegar: the death cap, if let boil for a long time, remains poisonous, just like other deadly poisonous mushrooms,
- Those mushrooms which exude latex or "milk" are poisonous; the Tawny Milk cap mushroom and the saffron milk cap that exude milk are among the most savoury mushrooms,
- It is extremely dangerous to believe that all mushrooms which are gnawed or partly eaten by animals (insects, snails, rodents, hoofed animals etc.) are edible because some animals are resistant even to the deadly poisonous mushrooms. The destroying angel (Amanita virosa), the deadly poisonous mushroom, is always gnawed or completely eaten by snails and rodents,
- Dried mushrooms are no longer poisonous: the Fool's Web cap (Cortinarius orellanus), even dried, remains deadly poisonous,
- Strong, sour, bitter-tasting mushrooms are poisonous: the mushroom Albatrellus confluens has rather bitter taste which is lost in dried and canned mushrooms, the milk caps (Lactarius rufus) has a very bitter taste, which is lost after the mushroom is preserved in vinegar; the alder bolete (Gyrodon lividus) is known for its very sour taste,
- It is widely known that poisonous mushrooms act as a curdling agent which causes milk to curdle: the most delicious forest mushrooms, which grow also in our forests, act as a curdling agent (Caesar's mushroom),
- There are many more misconceptions, such as; if mushrooms sprout in burn areas they are not edible; the mushrooms which are as multi-coloured as venomous snakes are poisonous; the mushrooms which smell bad, the mushrooms with tiny spikes, scales or hairs; the mushrooms that grow in a bunch; red, purple and blue cap mushrooms; all slimy mushrooms; the mushrooms that grow on a bad surface (manure, garbage heap, etc.)

#### 7.4. Mushroom Collecting Equipment

Mushroom collecting requires adequate equipment which is adapted to various agro ecological conditions. In addition to good waterproof rubber boots or high shoes, collectors also need to wear warn clothes for protection and comfort in humid forests, a strong staff to move away ferns, tree branches and leaves, and especially when looking for chanterelle mushrooms poking up from a carpet of fallen leaves, a sharp mushroom knife for brushing off soil, needles and leaves, a brush, and possibly a broad-brimmed hat or a visor hat to protect one from sun, one or two light baskets, several plastic bags and a pair of rubber gloves for picking poisonous mushrooms, handkerchiefs or a piece of cloth for cleaning the hands and the knife each time it has been used. As one put mushrooms in the basket, one need to put a layer of ferns to protect the mushrooms from damaging. One also needs a bottle of water and some food. One should never be alone in an unknown location, as one can get lost more easily than one thinks, and the company is needed also in case of an injury, snake bite etc. If one has a bad orientation in space, one should buy a compass; bring a whistle or a mobile phone with them.

One should be careful about where to place collected mushrooms. Shopping bags, paper grocery bags, nets, backpacks, plastic bags etc. should never be used as they can rough up, crack and squash mushrooms, or prevent them from breathing properly. Mushrooms do breathe, transpire, and after they are picked, the warmth that develops causes mushrooms to decay more quickly, if there is no air circulation, and is conducive to bacterial growth. The worst are plastic bags in which malformed mushrooms can decay within two hours only, as they do not breathe. This is why a wicker basket or cardboard boxes without cover are a necessary piece of equipment, although they are not easy to carry as the mushrooms turn over easily. Mushrooms decay easily and quickly because of a high percentage of proteins, resulting in a poisonous effect of even edible mushrooms. When they get poisoned, the mushroom collectors blame mushrooms and not their lack of caution.

Some people put into buckets everything they see and once all the mushrooms are inside the basket, they get mixed and cracked, and even the best expert won't know which piece is edible and which is not. They may easily get poisoned.

When collecting mushrooms, the fruiting body should not be pulled up from the ground; rather, they should be slowly turned around and picked with an upward motion together with the stem; collectors should be careful not to damage the ring, if any, and the hole in the ground should be covered with soil, leaves, moss etc., in order to protect the mycelium (basal) from which mushrooms grow. The stem end should not be cut off with a knife as it gives free access to parasites, rain, inspects and animals to the mycelium, thus preventing the mushroom growth. In addition, the beginners may fail to notice an important characteristic and may fail to identity a mushroom and eventually pick a poisonous mushroom instead of an edible one. This rule does not apply to the mushrooms that grow on tree trunks and which have hard and woody stems.

They are cut off close to the tree so that as little as possible remains exposed to external effects. It is necessary to find a number of the same species in different stages of development as many characteristics are visible in different stages. The waste of industrial origin (packaging etc.) should not be left behind in nature; it should be discarded to the waste bin. This is the best way to protect the areas where mushrooms grow. At least 10-20% of a species should be left within a habitat as the minimum for reproduction purposes. If one picks a mushroom which cannot be used (old, rotten, wormy etc.) it should break it into pieces and throw them across the habitat.

Before placing a picked mushroom inside a basket, the mushroom should be examined thoroughly one more time, and one should be certain that it is edible; any soil, dirt and insects should be brushed off. Hard and woody stems or stem butt need to be cut off and a slimy, sticky veil removed from the cap, and leaves brushed off. Old, wormy and mouldy and too wet mushrooms or the mushrooms which cannot be identified should not be picked. Some mushrooms absorb poisonous substances (arsenic, mercury, chromium, beryllium, vanadium etc.) and should not be picked if they grow near industrial facilities and roads.

One should never put their hands deep inside the bushes or lift stones as this may run a risk of seeing **venomous snakes**. In BiH only a horned viper and a common adder are dangerous.

#### 7.5. Mushroom Collecting – Basic Rules

- There is no single rule or method for distinguishing edible from poisonous mushrooms with great certainty, except for chemical analyses in laboratories.
- When out in a field or forest, one should not rush but to try to acquire the habit of observing and noticing.
- One should never identify easily and too quickly new species of fungi.
- One should pick only those mushrooms which are known for certain to be edible.
- If unsure or having even the slightest doubt about the mushrooms picked or bought in a market place, one should consult an experienced mushroom grower or simply throw them away.
- One should always pick the whole mushroom with a stem, pulling it up slowly, and paying attention to the stem butt. Special caution is required for mushrooms with red or reddish-brownish leaves and integument at the stem end.

- One should pick healthy mushrooms only. Old mushrooms that began to rotten, which are soft, mouldy, and very wormy or smell bad should not be picked. If stems are too hard and if their veil is slimy, they should be cut off.
- Mushrooms should not be pulled up abruptly; rather, they should be turned around in a slow motion and pulled up.
- Very young and undeveloped mushrooms should not be picked.
- Poisonous mushrooms should not be put together with edible ones as poisonous spores fall over edible mushrooms.
- Picked mushrooms should not be kept in plastic bags; rather, they should be kept in baskets or paper bags.
- One should never walk over or turn over non-edible and poisonous mushrooms as this would cause misbalance in nature.
- If unfamiliar with mushrooms, one should never pick them alone, on the basis of pictures, as mushrooms in nature are often different from what can be seen on the pictures.
- One should be careful not to pile the fresh mushrooms on top of one another, spread them out directly on a paper towel, in a room with sufficient air flow.
- Mushrooms should not be cooked for the next day; they should be eaten right away.
- Salt should be added toward the end of cooking, otherwise they will be hard.
- If frozen, mushrooms will lose smell and taste.
- One should never eat lots of mushrooms at once as our bodies cannot digest mushrooms easily. They should be chopped prior to cooking.
- Young children should not eat mushrooms as they do not have digestive enzymes developed yet.

- One should not cut mushrooms at the stem butt as this would prevent an access to parasites, insects, animals, rain which will destroy the mycelium from which mushrooms grow.
- Mushrooms should not be washed, no water should be added to them as they contain too much water; otherwise, they will become insipid.

## 8. Mushroom Processing

The overall mushroom production and the mushrooms from wild population (wild) are subject of the most necessary treatment only, which includes drying, freezing, pickling etc. There are no facilities in BiH which would base their strategy on mushroom processing to yield final products. An increased mushroom production opens both the possibility and the need for mushroom processing under the strategic target:

Final perspective mushroom products are frozen and packed, pasteurized and marinated canned mushrooms, double concentrate cream soup, frozen mushrooms. The freezing process under economic criteria would serve the purpose if there is an increase in mushroom production or import. A modern mushroom processing plant may serve also other purposes, primarily, fruit and vegetable processing and packaging.

This would require the peeling, washing, cutting, boiling and canning under low temperatures, by pasteurization and sterilization (Attachments 1, 2, 3, 4, 5, and 6).

## 8.1. Drying Mushrooms

The mushrooms picked correctly and of a good quality are placed in baskets or wicker baskets carefully, and delivered to a drying plant the same day they have been picked. Following delivery of mushrooms to the primary local buyer; the supply is weighed; then, trained workers sit at a table and brush off carefully the ground and other dirt.

At the same time, they cut off damaged parts with a sharp knife and cut the stems even (special attention is paid to cleaning and cutting the stem butt of edible bolete).

The mushrooms prepared in this way are grouped into class I and class II and are sliced with an electric slicing machine into equal 5-7 mm stripes which depends on the percentage of water in every mushroom. This applies to the majority of species and to edible bolete in particular. Some species contain more water than others and tend to be more fragile, beginning to decay and getting worms. Sliced mushrooms are placed carefully over wattles, making sure that the slices do not come on top of one another and that they are spread equally all over the wattles. When all the wattles are covered with mushroom slices, tippers take the wattles to the tunnel of the drying plant, the door of the tunnel is closed, and the drying process starts. The drying process lasts for an average of 4 hours with the drying temperature during the first 3 hours of around 45 °C, and during the last hour around 70°C. Dried mushrooms are loaded onto the tippers and are cooled at room temperature, and after 1-1.5 hours they are taken from the boards carefully and equally distributed into packages.

The packaging is usually cardboard three-layer boxes with polythene bags which once filled and made even are twisted and tied into a knot. The cardboard box is then closed with an adhesive tape, labelled and placed in a special storehouse until it is delivered to the buyer. The temperature in the storehouse should be -10 °C or lower, in order to avoid damage and deterioration of a quality. The best practice would be to store the bags on the special shelves or in metal ram palettes whose maximum height does not go over 140 cm. Otherwise, the cardboard boxes and the bags inside the boxes can be damaged, rendering a lower quality of the mushrooms.

There is a variety of drying chambers used for both cultivated and wild mushrooms. Those are primarily:

- chambers,
- tunnel dryer,
- belt conveyor dryer
- solar dryer



Picture 1. Preparation of mushrooms for drying

#### 8.2. Freezing Mushrooms

Delivered mushrooms (and edible bolete in particular) are weighed and then remnants of compost and dirt are carefully brushed off. At the same time, damaged parts are cut off with a sharp knife and the stems are cut even. Only the best mushrooms with medium-sized caps are frozen and other mushrooms are dried or pickled. The mushrooms selected for drying are placed carefully into a perforated plastic packaging, and then carefully placed onto the wooden pallets. They are frozen in a tunnel, at -35 - -40 °C. After 8-10 hours, frozen mushrooms are taken out of the tunnel and packed in cardboard three-layer boxes with polythene bags which are tied into a knot. Then the cardboard box is sealed with an adhesive tape. The closed boxes are properly labelled and stored in a temporary freezer warehouse at - 20 °C until they are delivered to the buyer.

#### 8.3. Pickling Mushrooms

The pickling process is relevant only for chanterelles which are placed in a perforated plastic packaging and delivered to the pickling chamber the same day. Pickled chanterelles are a semi-finished product, canned with a certain concentration of table salt in water solution in plastic 201/1 barrels.

Delivered chanterelles are grouped into class I and class II; leaves and mechanical dirt are carefully brushed off, and then they are placed into a pot. Perforated pot has to be made of stainless steel; also the kettle in which water is boiled should be made of stainless steel.

The pot filled with chanterelles is sunk into the kettle with hot 90 - 95  $^{\circ}$ C water for 4-5 minutes. Then, the pot is taken out and slowly cooled under a cold shower. Chanterelles are then carefully poured into plastic 201/1 barrels.

Prior to these steps, the barrels are filled with 20% saline solution, 5-6 cm below the rim, so that chanterelles account for about 70% of the overall weight after the water is drained off. The full barrel with a proper screw joints is closed by cover and is rolled on both sides over a cold surface in order to make the saline concentration even. The 1.200 x 1.000 mm barrels with pickled chanterelles are placed onto a wooden palette, three by three, under the porch or in a closed room until delivery.

## 8.4. Packing Mushrooms

That is the process which consists of a number of simple operations. Packing varies with different types of mushroom. Still, the principles are the same:

- preparation of packaging
- weighing mushrooms and filling the packaging
- closing the packaging

It is easy to prepare ready-made packaging for mushrooms: every packaging, one by one, is placed on a transporter which will bring them to the filling machine. The stackable packaging needs to fit into a room (boxes made of paper cardboard, corrugated cardboard, stackable wooden boxes). If packaging gets dirty, it needs to be washed and cleaned and sometimes sterilized.

Packing materials are: BOPP bags, stretch sheets, mushroom boxes, nets, perforated bags.

## 9. Networking Within the Sector

The obligation of networking within the sector and the creation of a professional association are mentioned in the description of the current situation, problems and solutions. The task of the association would be:

- To follow and implement the law at the level of BIH,
- To create and apply the sector's development policy,
- To influence planning and implementation of development papers (development strategies, support projects, loan policy),
- To provide professional services to mushroom producers and collectors,
- To create the documentation basis and a service sector for the sector,
- To establish an information system within the sector.

## 10. Level of knowledge and skills

Advisory services are established in the agrarian sector at the level of BiH. Their task is to train stakeholders in the mushroom sector. Unfortunately, the issue of an advisory service has not been properly resolved in the FBiH. At present, there are cantonal branches without any serious institutional powers or responsibility. The mushroom growers are forced to rely on professional services through different and very complicated channels, mainly in the countries in the region. Advisory services for mushroom collection are provided by the Association for Medicinal Herbs which may serve as an efficient model. Even mushroom growers could join the Association and they could form separate association which will take over the advisory role for mushroom growing sector only.

According to the results of the survey conducted among mushroom growers, the main problem seems to be the lack of knowledge in production, processing and especially in networking the producers for market purposes.

## 11. Access To Market

## 11.1. Situation and Tasks of Market Development

In view of the ongoing globalisation and a strong desire for liberalisation of all products it is crucial that the current mushroom producers strengthen their own production, efficiency and increase quality in a competitive market which involves their partners from the countries in the region and beyond. The infrastructure available to the mushroom growers is not sufficient for some efficient arrangements for an organized sale of cultivated mushrooms.

- First and foremost, it is necessary to build such a system which could meet the demands of mushroom growers and collectors when they can offer and sell mushrooms to potential buyers in the domestic and foreign markets. True, this would require also some technical and technological conditions (freezing facilities, drying chambers etc.).
- Such a market should have equally functioning inputs, which will ensure purchase of the materials necessary for cultivating mushrooms.

The avenues to the above-mentioned market demands should imply:

- Identification and outlining the real market and potential market mushroom producers from sporadic and non-market-oriented players,
- Assistance and provision of information to mushroom producers and collectors so that they can always answer the question: how much, which types of mushrooms and under which conditions mushrooms will be produced for a known buyer,
- Building a system of stimulating the mushroom growth for the purpose of developing competitiveness in the domestic and foreign markets (regular agricultural incentives, export premiums etc., in accordance with WTO rules), improvement of legislation and establishment of quality control in the internal and external markets,
- Harmonisation of standards, establishment of procedures, institutional capacity building and ensuring development conditions in the forthcoming international integration processes.

**Internal market landscape** should be developed by improving the current and developing the missing legislation in the area of overall production; by establishing the market system institutions; and by building a more efficient market infrastructure.

- These measures would be sufficient for overcoming difficulties arising from the small mushroom production (natural production),
- Stronger links would be established between mushroom collectors and producers and the food processing industry,

• These would shape and promote competitiveness of domestic production and collection practice in the rural areas of BiH.

Merging to increase the volume of supplies can be achieved through the following measures:

- Small mushroom producers prevail in the overall production structure (60%) and their low scope of production poses high barriers to creating a competitive market supply,
- The way in which this problem should be solved until a larger, more unified structure is created, is support for the current "**sound**" practice and for the creation of new adequate facilities for mushroom growth
- Merging wild mushrooms buyers and mushroom producers will create commercial entities capable of managing stronger business enterprises.

**Networking within the sector** of mushroom production and collection, due to heterogeneity of both the volume of production and in technical and technological aspect, is very complex, and vertically and horizontally multi-layered. The networking can be achieved only on the market principles and by building direct business links. Those links imply concrete and long-term business cooperation.

Achieving competitiveness in the market implies that all stakeholders in the mushroom sector will get stronger in marketing terms. Before that, it is necessary to continue to implement the current and introduce new, acceptable forms of market regulation, as stated above. The range of products should be expanded in the mushroom production structure (to grow and collect the mushrooms demanded by the market), regardless of how more complex cultivation conditions would be needed.

**Modernisation of the market infrastructure** in the sale of wild and cultivated mushrooms requires more diverse and better distribution channels, without which it will not be possible to achieve the set goals, described in this study, or revitalize the sector.

Modernisation of the market infrastructure implies that it will meet the complex marketing principles and will bring:

- A complete, and of a good quality purchasing system, and
- Its efficient internal and wider coverage.

As there are no defined measures in the mushroom production and collection sector in BiH, these should be strategically developed. In order for these measures to be implemented, it is necessary to include government and non-government institutions, to create marketing centres, business associations, to establish links with food-processing industry, auction and stock market trade, fair institutions and promotional events, the system of whole-sale markets, the system of mushroom freezers etc.

The whole system of measures should be covered with timely information on all relevant events in the domestic and foreign markets. This can be achieved by establishing a *market information system* within the sector.

One of the key market requirements are certainly various forms of certification which recognize very important values of the general civilisation relevance (Codex Alimentarius) as well as a whole series of issues related to political, economic and social arrangements in the countries in transition, a dialogue between the rich and the poor, gender relations etc. So, the suggestion would be the first step in certification of a HACCP system in the mushroom production which includes the following components: GMP (good manufacturing practice) and GHP (good hygiene practice).

#### 11.2. Supplies and Competition

Some 180 producers with adequate facilities and as many as smaller producers with inadequate production facilities have been identified in the BiH mushroom production industry. The mushroom collection process involves a great number of citizens, especially rural population. 72 companies have been identified to be involved in the process of purchase *and treatment of mushrooms (drying, freezing, pickling).* 





#### 11.3. Margin Cost and Value Chain

The wild mushroom prices are varying a lot at the level of collection, retail sale and wholesale. As expected, the collectors get the smallest share in the value chain. Due to some major differences in the prices per type of mushroom, it is difficult to establish an average price which a producer gets per one kilogram. The whole prices of wild mushrooms are 3-4 times as high as the amount paid to the collector, and retail prices are nearly 10 times as high. In terms of cultivated mushrooms, the prices are equal on the BiH market. There is a limited supply of wild mushrooms to the BiH market and only a small number of mushrooms of natural populations can be sold easily.

| No   | Name of mushroom               | Price in BAM |       |             |
|------|--------------------------------|--------------|-------|-------------|
| INU. |                                | Collector    | Buyer | Retail sale |
| 1.   | Edible bolete (Boletus edulis) | 7,00         | 12,00 | 35,00       |
| 2.   | Morel (Morchella conica)       | 12,00        | 20,00 | 70,00       |
| 3.   | Chanterelle (Cantharellus      | 2,50         | 5,00  | 14,00       |
|      | cibarius)                      |              |       |             |
| 4.   | Caesar's mushroom (Amanita     | 6,00         | 10,00 | 35,00       |
|      | caesarea)                      |              |       |             |
| 5.   | Black trumpet (Craterellus     | 1,00         | 1,50  | 3,50        |
|      | cor.)                          |              |       |             |
| 6.   | Saffron milk cup (Lactarius    | 1,00         | 1,50  | 3,50        |
|      | deliciosus)                    |              |       |             |

 Table 10. Price of mushrooms in the overall chain (collector – buyer – retail sale)

## 12. Indicators Of Implementation - Impact

The task of the study is to encourage constructive changes that will improve this sector, especially the aspect of an inclusive sustainable market, in order for more rural population to become a part of this supply chain within their own households, and for many small growers to meet the requirements for approved market production. In this case, conditions would be created alongside with technical and technological training which would help producers to become competitive in domestic as well as the overseas markets. The study points to the needs, directions, and scopes which are necessary steps for development of the sector and the basic principles which will enable an access to the market. Success will be measurable if there is a positive economic impact and if the rural environment provides better platform for sustainable livelihood. The results of the above proposed measures for revitalization of the sector will be reflected in:

- The overall growth and value of cultivated mushrooms,
- Increased employment of rural population.

Increasing the volume of cultivated mushrooms requires a brave step forward which will be directed, either directly or through processing, to the market and thereby ensure income for those who are part of the production cycle. Regardless of a legitimate possibility for an increased and more diverse mushroom production, the production variety will be moving ahead under the structural physiognomy which will be in accordance with the marketing signals received from the internal and external environment.

**The growth of production value** shows the possibility for increasing the value of mushroom cultivation from the current 2.135 t (BAM 8 million) to 3.440 t (BAM 13 million) by 2015.

The employment growth under the planned dynamics of the sector development and improvement of the structure through the set of measures envisioned in this study would be as follows: in addition to closely following market demands for specialized mushroom production, possibilities would be created in parallel with a lot of "part-time" employment opportunities where mushroom growing could be an extra job. The progress in the sector will encourage directly and indirectly the food-processing industry, trade, tourism, catering industry, transport and some other, related activities. Despite some numerous efforts to define various development programmes for the rural areas, the mushroom sector has a chance to inject a new economic weight to that area.

**Financial investments** will stimulate the investment cycle as a necessary condition for inclusion in the competitive market and implementation of the set goals. The estimates of the future sector development and the estimates on the possible savings in equipment and adaptation of facilities present financially different investment models. The frameworks for merger of the financial resources and management should be within the Development Bank's fund for financing and rural development, the payment agency etc. Most of funds should be farmer's own supported by favourable loans and credit lines.

Managing implementation of the planned measures, as proposed within this study, is somewhat complex and requires good organisation and management. In terms of the overall rural environment, actions in all segments will have to be coordinated, including those in the mushroom sector, the collection of wild mushrooms and plans for other economic sectors, in order to improve the quality of life of those who chose to live in rural areas. With outlined goals and activities, the study needs implementation which will be meaningful, timely and cost-effective. It would be necessary to create an organisation (an association) which would provide, within the area of medicinal herbs and bee keeping, strong support to those activities which are part of the overall revitalisation of life in the villages.

## 13. Social and Environmental Assessment

A rich variety of mushrooms and other forest products in BiH, long tradition of collecting, processing and sale of products domestically or internationally are just some of the reasons why the mushroom and medicinal herbs sectors in BiH are favoured for a number of good reason in terms of economic, social, health and environmental aspects. The human factor, unfortunately in addition to protecting environment and mushroom growth, often has also negative impact on the mushroom breeding and wide distribution.

There are three main factors which have a negative impact on mushrooms: changing, disappearance and fragmentation of mushroom habitats, pollution of environment and inappropriate and excessive collection of edible mushrooms. An individual impact on mitigation or reduction of the first two factors is rather limited. Non-rational wood cutting leaving behind bare ground, excessive urbanisation, expansion of roads, hydro accumulation, open coal mines, forest fires, global pollution, air pollution, acid rains, heavy metals etc.

A problem of the disappearance of many species of fungi is a result of changed soil acidity and environment pollution in general.

An individual has a huge impact on the inadequate and excessive mushroom collection. The mycelia of many types of mushrooms are short-lived, for around ten days, developed once or more within a season, or not develop at all under inadequate conditions. As mushrooms cannot propagate or disperse without spores, the main threat comes from excessive, spontaneous, uncontrolled and unprofessional mushroom collection. If all mycelia are removed from an area, new mushrooms will never grow again. Human cause serious damage by pulling up the mycelia, by digging, raking and by exposing delicate endings of mycelia to bad weather, sun and animals. By collecting young mycelia which have not started releasing spores, one prevents them from performing their function. Also, by collecting old mycelia, which are no longer tasty, one does not allow many spores to remain in the ground as the mycelia are decaying.

An increasing need of selective and subtle customers and markets for mushrooms and their products requires a rational exploitation and preservation of the overall bio-diversity. 200 types of edible and 60 types of poisonous and deadly poisonous types of mushrooms have been identified in BiH. This sector is dominated by traditional collection of wild mushrooms, which includes around 30,000 families as groups of collectors in rural areas.

## The environmental and social assessment clearly shows the following:

- Mushroom collectors' income is not either adequate or guaranteed;
- There is a lot of space for a more equal distribution among collectors, wholesale and retail ends of the value chain;
- Although many edible types of wild mushrooms are rarely used, there is a bigger share of economically more important mushrooms which are at the risk of becoming rare, under threat and potentially protected mushrooms.
- If demand for a certain type of mushroom exceeds its existence and quantities available in the nature, collection of such types would not be sustainable;
- The companies, involved in purchase within a sustainable mushroom collection, are the most responsible for preserving biodiversity;
- In view of an extreme importance of the views of those who are involved in mushroom trade, it is extremely important to promote and improve the overall understanding of this sector and promote sound and sustainable business practice.

#### Mushroom collectors' income can be increased by:

• Improving the equality in the supply chain in order for collectors to get a greater value of the product;

- Enabling the collectors to get a better price through added value;
- Enabling the mushroom collectors and producers to sell more products;
- Enabling the collectors to diversify the activities which bring them profit.

#### Sustainable mushroom collection can be promoted through:

- Improvement of the overall arrangements for resource management;
- Support to interest groups to manage this sector in a sustainable way through:
  - Supporting creation of an association of mushroom collectors and producers,
  - Training of collectors about rational mushroom collection,

As the most efficient way to protect the overall forest resource including wild mushrooms is to develop a document which will define a status of mushroom (economically important, rare, risky, protected) and enable the Forest Associations in FBiH and the Forests of RS to issue certificates which will define the permitted collection volumes of different types of mushrooms for different regions.



Table 1. Structure of population (ex, age and status) in the mushroom collection area

## 14. SWOT ANALYSIS

| Project Logic                                                                                                                                                                                                                                                                                                  | Objective indicators of the<br>Project                                                                                                                                                                                                                     | Sources of<br>verification                                                                                                    | Assumptions                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Through progress in terms of an<br>increased volume and structure of<br>mushroom production, improvement<br>of market, increase employment of<br>different age and sex groups of rural<br>population in BIH.                                                                                                   | Numerous interests and<br>readiness of rural population<br>for mushroom production.                                                                                                                                                                        | Objective<br>information about the<br>possible export of<br>cultivated and wild<br>mushrooms.                                 | Mushroom production does<br>not face sudden shocks or<br>bigger risks. It is expected that<br>in the next years there will be<br>a greater interest in fresh and<br>also processed mushrooms. |
| <b>Purpose and goal</b><br>Direct a certain portion of rural<br>population to mushroom production,<br>to achieve stable (sustainable)<br>production, to establish a better<br>functioning market.                                                                                                              | To produce a greater<br>volume, and more diverse<br>mushrooms, to can,<br>dehydrate, freeze, pack,<br>design, and certify products.                                                                                                                        | Partner confirmation<br>of the progress made<br>in quality and an<br>increased level of<br>knowledge of<br>mushroom growers   | Delivery of mushrooms in<br>fresh and dehydrated forms is<br>regular, independent from<br>changing weather conditions<br>(mushroom growth has<br>improved quality)                            |
| <b>Result 1</b> :<br>Increase participation in the value<br>chain and enable mushroom<br>producers to receive a higher value of<br>the products. To ensure the market<br>for sale of a bigger variety of<br>products and bigger quantities and to<br>create direct trade links (the most<br>important segment) | A transparent business plan<br>on the basis of which a<br>financial structure of a new<br>investment will be clear. A<br>clear organisation of a<br>registered mushroom<br>producer, trade or company,<br>a proper financial and<br>administrative system. | Documents on the<br>business operations<br>of a legal company or<br>an individual. A<br>business plan, books,<br>reports etc. | Memorandum of<br>understanding regulating<br>cooperation with foreign<br>partners, cooperatives,<br>faculties and institutes of<br>agriculture.                                               |
| Result 2:<br>To ensure a greater participation of<br>labour engagement of rural<br>population in mushroom production<br>(increased employment)                                                                                                                                                                 | An association established.                                                                                                                                                                                                                                | Inspection. Contracts<br>prepared or<br>concluded, quality<br>certificate.                                                    | No delays in obtaining import<br>permits for equipment and<br>technology, and for export of<br>mushrooms                                                                                      |
| <b>Result 3</b> :<br>To test different models of<br>sustainable mushroom growing in<br>comparison to sustainable form and<br>structure of production, adaptation of<br>existing or building new facilities.                                                                                                    | Possibilities to produce<br>mushrooms in adapted<br>unused facilities, by-<br>products from the process of<br>primary agricultural<br>production as a basis for<br>growing oyster and shiitake<br>mushrooms.                                               | Possible complaints<br>and grievances to<br>mushroom suppliers.<br>Company's<br>accounting books.                             | Customers recognize quality<br>and are willing to pay a bigger<br>price for mushrooms with<br>EKO and/or ISO and HACCP<br>certificates.                                                       |

## 15. Case Studies

In examining the case studies, the author analysed the possibility for and interest in mushroom production, especially in the areas with extremely difficult living conditions. Based on the available findings, pilot municipalities of **Prača and Fojnica** have been selected as examples with possibility for implementing some of the key measures from this study.

## Situation

Extremely under-developed municipalities; the lack of economic activities; Natural resources are not utilised. A pronounced depopulation (young labour force migrates to urban areas). Evident high unemployment. Municipal authorities and population are interested to expand current agro business, mushroom growing in particular. There are many privately owned facilities which can be adapted for the purpose of mushroom production. The municipalities do not have recourses for development projects, although they have expressed their willingness to implement the mushroom growing project within their abilities.

#### Problem

Agro ecological conditions and farm sizes are not adapted to a specific market production which requires larger farms. Possible, sustainable production aspects are within intensive production (smaller production areas) or production in closed areas (i.e. mushroom production). Young people are dependent and are looking for the initial financial input for start up business. The municipalities are in the canton with smaller revenues, which cannot provide any major support to the agricultural sector.

## Solution

Analyses of those population groups who are interested in mushroom production. The analysis would include the following elements: age structure of potential producers, environmental conditions for production (level of adaptation of an existing facility or the input available for building a new facility), whether the producer is ready to accept professional advice and how professional and cooperative, whether the producer is willing to be in the system, the household's infrastructure, the type and volume of mushroom production (preference given to oyster and shiitake mushrooms), whether the producer has resources for compost, etc.

## **Priority**

• To develop a questionnaire and carry out an analysis of interested producers, mark potential market producers. To deliver training on production requirements, profitability and sustainability.

#### Mushroom Production Scheme

![](_page_42_Figure_2.jpeg)

## **Packing Scheme**

![](_page_43_Figure_2.jpeg)

## **Primary Preparation**

![](_page_44_Figure_2.jpeg)

#### Freezing Mushrooms

![](_page_45_Figure_2.jpeg)

#### Mushroom Canning Block Scheme

![](_page_46_Figure_2.jpeg)

Soup Production Scheme

![](_page_47_Figure_2.jpeg)

#### **Product Formulae**

MARINATED MUSHROOMS

| • | М       | ushrooms class I, selected, boiled | 65% |
|---|---------|------------------------------------|-----|
| • | Mixture |                                    | 35% |
|   | -       | Acetic acid                        | 4   |
|   | -       | Table salt                         | 2   |
|   | -       | Sugar                              | 1   |
|   | -       | Spices                             | 1   |
|   | -       | Water                              | 92  |

#### STERILISED MUSHROOMS

| • | M       | ushrooms class I, selected, boiled | 65% |
|---|---------|------------------------------------|-----|
| • | Mixture |                                    | 35% |
|   | -       | Table salt                         | 2   |
|   | -       | Sugar                              | 2   |
|   | -       | Spices                             | 1   |
|   | -       | Ascorbic acid, citric acid         | 1   |
|   | -       | Water                              | 96  |

#### CREAM SOUPS – SAUCES

| - | Mushrooms class III             | 50% |
|---|---------------------------------|-----|
| - | Oil and butter                  | 5%  |
| - | Wheat flour                     | 5%  |
| - | Cream 18% of fat                | 12% |
| - | -Tuberous vegetables and onions | 28% |

#### Modern Mushroom Purchasing Facility -

#### **Processing Plant** -

![](_page_49_Figure_3.jpeg)

Figure 1

- 1. electric mushroom cutter
- 2. universal drying chamber
- 3. cooling chamber
- 4. decanter
- 5. boiler-room
- 6. toilet block
- 7. mushroom unloading porch
- 8. drying porch
- 9. product loading porch

#### **Economically Important Cultivated Mushrooms**

![](_page_50_Picture_2.jpeg)

White button mushroom *Pleurotus s.*)

Shiitake (Lentinula e)

Oyster mushroom (Agaricius b.)

#### Economically important mushrooms of natural populations

![](_page_50_Picture_7.jpeg)

GOLDEN CHANTERELLE SAFFRON MILK CAP BLACK TRUMPET (Cantharellus cibarius) (Lactarius deliciosus) (Craterellus cornucopioides)

![](_page_50_Picture_9.jpeg)

EDIBLE BOLETE (Boletus edulis) MOREL (Morchella conica)