INDIAN MUSHROOM INDUSTRY- PAST AND PRESENT
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HISTORICAL

India is fortunate to have a varied agro-climate, abundance of agro-wastes, relatively low-cost labor and a rich fungal biodiversity. These factors combined make India a potential major producer of temperate, tropical and subtropical mushroom species. Moreover, its enormous population could support the large-scale consumption of nutritious mushrooms by a significant health-conscious urban population as well as the rural masses struggling with hunger and malnutrition, particularly vegetarians who rely heavily on a cereal-based diet. In view of these unique strengths, the FAO (Food and Agriculture Organization) emphasized the adoption of mushrooms as an ideal food for the protein-hungry masses of developing countries. And, accordingly, the Indian Council of Agricultural Research (ICAR), New Delhi, the principal organization formulating and guiding farm research activities of the country, sanctioned a program "Development of Mushroom Cultivation in Himachal Pradesh".

The newly sanctioned mushroom development program was set-up at Solan, a small town situated about 45 km from Shimla, the erstwhile summer capital of British India. The program functioned under the auspices of Agriculture College, HPKVV, Palampur, and subsequently under the Y.S. Parmar University of Horticulture and Forestry at Chambaghat, Solan (Verma,2004), which had made some pioneering contributions to mushroom research in India. The program was launched in 1961 by the state government of Himachal Pradesh and was later (1971-79) converted to the ICAR Coordinated Mushroom Research Project, with Solan as the main centre and with three coordinating centres located at Ludhiana, New Delhi, and Bangalore in order to give the necessary research support to different mushroom species requiring different climatic conditions. At about the same time, the FAO appointed mushroom consultants to Solan [Drs. E.F.K. Mantel (1965-72) and W.A. Hays (1974) and Mr. J. Tunny (1977-82)] to help create the infrastructure for basic and applied mushroom research, and to rapidly transfer new technologies, including spawn and ready-made substrates, to commercial growers.

In 1983, the ICAR Coordinated Research Project Centre at Solan was elevated to the National Centre for Mushroom Research and Training (NCMRT), with an all-India mandate to conduct research on mushroom production, protection, preservation and utilization as well as to train scientists, teachers, extension-workers and growers. ICAR also sanctioned an all-India Coordinated Mushroom Improvement Project (AICMIP) with headquarters at NCMRT, Solan and five coordinating centres [Punjab Agril, University (PAU), Ludhiana; G.B. Pant University of Agriculture and Technology (GBPUART), Pantnagar; Tamilnadu Agricultural University (TNAU), Coimbatore; Mahatma Phule Agricultural University
(MPAU) Pune, and Indira Gandhi Krishi Vishwavidyalaya (IGKVV), Raipur] to conduct mushroom research in different agro-climatic zones and also to conduct multi-location testing of the new techniques developed at Solan. Since then, not only the mandates of NCMRT were periodically revised and enlarged but the project was renamed the NRCM (National Research Centre for Mushroom) and recently elevated to the Directorate of Mushroom Research (DMR). Similarly, the AICMIP was periodically expanded to cover the remaining regions of the country. Presently, the project has 12 coordinating centres and three cooperating centres, reaching almost every agro-ecological zone in the country.

As the research base and the necessary infrastructure were created during 1961-1983, some enterprising growers and entrepreneurs in H.P. and Kashmir valley founded the Mushroom Industry of India by launching the first commercial farms producing the white button mushroom (*Agaricus bisporus*). These farms took advantage of the cooler climate in their locations, although the first such farm was started at Solan by a woman entrepreneur Mrs. Madhu Kohli in 1965. Other early commercial farms were (i) M/s Tegh Masarado, Doch, Chail (H.P.) established by Captain Amrinder Singh, Maharaja of Patiala in 1968, (ii) Sehgal Mushroom Farm, Kasauli (H.P.), (iii) Colonel Kak’s Mushroom Farm, Srinagar and (iv) Brigadier Harmander Singh’s Farm at Ambala. The success of the pioneering commercial farms motivated other enterprising farmers to grow button mushrooms under natural climatic conditions during winter season only using low-cost improvised facilities. Here, the story of a sleepy village Badhana in the District Sonipat (Haryana) is worth recalling, where a schoolteacher Master Jagdev Singh first cultivated button mushrooms with a low-cost technology learned at NCMRT, Solan. This technology spread like wildfire throughout the immediate area, making Haryana a frontrunner in village-level button mushroom farming. Soon after, similar farms developed in Jammu and Kashmir, Punjab, Haryana, and Uttar Pradesh and even in the Neelgiri hill areas of south India. In fact, the strong demand for mushrooms in metropolis Delhi, Calcutta and Bombay and large cities, such as Pune, Bangalore, Hyderabad, Coimbatore, Bhubaneshwar and Jamshedpur, encouraged the commercial-scale seasonal farming of mushrooms, which quickly took form as a thriving cottage industry in north west India (Figs.1 & 2).

![Figures 1 & 2. Seasonal farms near Delhi and Ooty.](image-url)
RESEARCH AND DEVELOPMENT SUPPORT

Research support for mushroom growing continued to expand through contributions from diverse organizations, such as (i) Council for Scientific and Industrial Research (CSIR) by way of their research laboratories at Srinagar (J&K) and Jorhat (Assam), (ii) ICAR, through the Indian Agriculture Research Institute, New Delhi, Indian Institute of Horticultural Research, Bangalore and Research Complex for NEH region, Shillong and (iii) agricultural and traditional Universities, Colleges of Agriculture, Calcutta and Pune, etc. Also, the government of India, during the VIII 5-year plan (1993-97), launched a massive drive to create 30 composting units and 29 spawn laboratories in 21 states dispersed throughout the country. This effort included an allocation of Rs. 1.36 Crores (ca. US$270,000) for training 27,300 mushroom growers.

International cooperation also continued to strengthen the infrastructure in India. Under an Indo-Dutch mushroom project, modern facilities to produce pasteurized short-method compost, casing soil and quality spawn were established in 1988 at four sites located at Palampur, Srinagar, Jeolikote (U.P.) and Bangalore (Karnataka). In addition, major contributions in mushroom research came from the National Center for Mushroom, Solan and can be summarized as follows:

1. Wild germplasm was cultured, identified and conserved in a gene bank with cryopreservation facilities. DNA fingerprinting of 43 accessions of *A. bisporus*, 9 of *A. bitorquis*, 51 of morels and 61 of different specialty mushrooms was done using RAPD, AFLP and ITS analysis. Two high-yielding SSIs (NCS-100 and NCS-101) and hybrid NCH-102 of *A. bisporus* were released for cultivation in 1997.

2. Production technology for specialty mushrooms *Lentinula edodes*, *Auricularia polytricha*, *Flammulina velutipes*, *Calocybe indica*, *A. bitorquis*, *Volvariella volvacea* and *Ganoderma lucidum* was standardized. Substrate pasteurization by chemical treatments for specialty mushrooms and long-method composting for the button mushroom were developed and adopted by growers. Organic production also was achieved for the button mushroom.

3. Preventive and curative measures were devised for of dry and wet bubble diseases. The bacterium *Serratia marcescens* was identified as a bio-control agent for beetles in oyster mushrooms.

4. Storage in perforated polythene packs (<100 gauge) at 5 °C was shown to enhance shelf life and preserve nutrition of the button mushroom. Ready-to-use mushroom curry in retortable pouches, mushroom preserve (Murabba) of button mushrooms and sugar-candy of oyster mushrooms were developed as new products.

5. Spent mushroom substrates were found to be effective as organic manure for field crops.
6. Nearly 2,000 farmers and entrepreneurs and 350 subject matter specialists were trained, including some from neighboring countries. The annual Mushroom Fair was held at Solan, which earned the distinction of “Mushroom City of India”.

7. ICAR bestowed the “Best Institution Award” on the NRCM, Solan in 1999 for its numerous achievements.

**EXPORT ORIENTED UNITS (Organized Sector)**

Recognizing the groundwork done and the potential of mushrooms as a high-value crop in the international market, the Indian government launched a plan to encourage entrepreneurs and business houses to set-up organized high-technology mushroom farms as industrial ventures. The plan, called “100% Export Oriented Units” (EOUs), was proposed to provide the following benefits and incentives to investors launching the EOU:

1. Industrial plots would be leased on concessional rents and would be eligible to build standard designed factory building sheds, etc.

2. Duty-free import of necessary capital goods, components, prototypes, material handling equipment, raw materials, office equipment and consumables.

3. Permit for 100% foreign equities.

4. Permit to export produce through an export house/trading house/star trading house.

5. Exempt from payment of corporate income tax for first five years of operation.

6. Permit to combine net foreign exchange earnings with the net foreign exchange earnings of a parent company in the domestic tariff area for the purpose of qualifying as an export house/trading house/star trading house at a later point in time.

The announcement of the EOU plan triggered a strong response from investors, and by the early 1990s, several farms based on imported technologies and with a production capacity of over 2,000 tons per annum (TPA) and with a potential maximal capacity of 100,000 TPA were registered for or installed at different locations throughout India (Verma, 1996). The EOU were integrated units using improved strains of the white button mushroom (*A. bisporus*), the spawn of which was imported from abroad, thereby meeting the stringent U.S. FDA quality standards. Most of these farms were based on Dutch technology and used machinery and designs of established Dutch companies. Undoubtedly, installation and functioning of the EOU units had a marked impact on annual mushroom production and average productivity, which by 1997 had approached 40,000 tons and 22 kg/q of compost, respectively. However, this impact was limited to the button mushroom, because the EOU did not produce other edible species even though some were located in tropical/subtropical regions with climates and available raw materials that were more conducive to specialty species.
Aside from the major EOUs, a number of smaller units were established with an output capacity of less than 500 TPA. Most of these units adopted indigenous technology for growing the button mushroom under a controlled climate using affordable, local-made machinery, so as to allow low-cost production. Mushrooms produced by these units were marketed within the country, although some were exported to countries having low import standards.

![Commercial mushroom farm near Pune.](image)

**UNORGANISED SECTOR**

Within the unorganized sector, a large number of seasonal mushroom farms growing different mushroom species, (*A. bisporus*, *Pleurotus* spp. and *Volvariella* spp.) appeared over the years and throughout the country. Mushroom species grown were selected based on the local climate, as both indoor and outdoor cultivation were practiced. Many of these operations relied on low-input, low-cost cultivation practices, including unpasteurized compost, chemically treated casing soil, and low-yielding mushroom strains. As such, productivity and product quality from these units were generally substandard. Cultivation was carried out using an improvised hut-type housing (Figs. 1 & 2) and poor hygiene, which resulted in a high rate of crop loss due to pathogens and pests. Seasonal farms made up only a small fraction of the total button mushroom production, but accounted for virtually the entire oyster and paddy straw mushroom crops (Figs. 4-6).

**MID-COURSE REVIEW**

With the purpose of assessing the performance of the Mushroom Industry of India and identifying its constraints and weaknesses, the National Research Centre for Mushroom, Solan, Mushroom Society of India and the APEDA (Agricultural and Processed Food Products Export Development Authority, Government of India) organized a one-day conference entitled “Mushroom Industry in India – A Decade of Achievement and Future
Prospects”, which was held on December 3, 1999, in Delhi. The deliberations at this well-attended conference covered the following contemporary issues:

**Indian Production vis-à-vis Export Scenario**

Overall production by the Indian Mushroom Industry from 1993 to 1997 showed a steady rise from 29,000 to 38,000 TPA. However, relative to the total world output of about 3 million tons in 1997, India lagged far behind other countries in output, which underscored the need for a more concerted effort to realize its untapped potential.

During the 1990s, global mushroom trade was on the increase, with North America, EU and Japan being the dominant importers. In 1996, the U.S. demand for fresh button mushroom imports was nearly 0.1 million tons, the bulk of which was supplied by China (48%), while only 7% originated in India (Kaul, 1999). Still, the U.S. was the largest importer of Indian mushrooms. Similarly, India supplied only about 13% of the mushrooms imported by the EU countries. In fact, the total Indian export to North America, EU and Middle East during 1996-97 amounted to only 10,138 tons, which was an insignificant fraction of the total world production at greater than 3 million tons. Further, it was estimated that the supply shortage for mushrooms during 2006 would approach 0.65 million tons globally and 0.27

Figures 4, 5 & 6. Rural spawn laboratory in Orissa; Oyster mushroom farm; Outdoor farm producing straw mushroom.
million tons in the U.S. (Kaul, 1999). Hence, India foresaw an excellent opportunity to capture a greater share of the U.S. import market during the early 21st century, which was strengthened by a heavy anti-dumping duty that had been levied on the major exporting country of China.

Clearly, India stood to substantially increase its share of the U.S. import market provided it could ramp up its resources to increase button mushroom production. Moreover, India would have to create the infrastructure for long-distance export of mushrooms, since there had been a shift in U.S. demand from processed to fresh mushrooms. This would be a daunting challenge as, in 1997, India could supply only 8,900 tons and 1,200 tons of processed and fresh mushrooms, respectively.

Japan was also a major importer of mushrooms, although its preference was for specialty mushrooms at the rate of greater than 0.15 million tons annually (Kaul, 1999). Prior to 1997, however, the specialty mushroom industry in India was largely undeveloped, making this export market opportunity unattainable.

Production cost and mushroom quality vis-à-vis the increasingly competitive international market were critical topics discussed at the conference. It was generally agreed that if India was to compete successfully with China in the export space, particularly the U.S., it would have to maintain a high-quality product while significantly reducing its cost of production. It was therefore concluded that during the coming years, India would have to (i) increase its production of the button mushroom while maintaining quality and cost, (ii) organize its production lines of specialty mushroom, so as to produce mushrooms of export quality for the Japanese market and (iii) create the infrastructure enabling the cold-chain supply of fresh and chilled product.

Global Mushroom Consumption Trend
An analysis of global mushroom consumption for 1996-97 showed that G-6 countries continued to lead, with U.S. at 30%, Germany at 17%, U.K. and France at 11% each, Italy at 10%, Canada at 6% and several other countries totaling 15%. However, the mushroom export pattern for India did not follow this global trend. In fact, other countries, such as Denmark (992 tons), Switzerland (765 tons) and Netherlands (639 tons), imported more mushrooms from India than did Germany (309 tons), France (196 tons), and the U.K. and Italy (0 tons each). The U.S. was the major importer (6,931 tons) of Indian mushroom during that year. The overall trend for mushroom consumption generally agreed with the income level and purchasing power of the consumer country.

During the mid to late 1990s, domestic mushroom consumption in India was estimated at only 20-25 g per capita. This low consumption rate was attributed to the limited availability of mushrooms, poor purchasing power of the consumer, lack of awareness about the nutritional and medicinal value of mushrooms and some taboos and superstitions associated with mushrooms in some regions of the country (Verma, 1999). The income level of India was increasing along with that in many other countries. Therefore, it was generally believed that mushroom consumption and demand would
increase as well, although the general lack of awareness by the consumer regarding mushrooms as a healthy food stood to limit the growth of the industry in India.

**Constraints**

1. It was noted that the EOU that relied heavily on imported technology for the exclusive production of the button mushroom faced a relatively high production cost. Hence, any slump in international pricing of imports threatened their profitability. In an effort to reduce capital cost, it was recommended that the EOU gradually shift to indigenous technology. It was also agreed that additional economic stability might be achieved by growing tropical or subtropical species, because international demand for specialty mushrooms was on the rise.

2. The EOU were sensitive to, and often adversely affected by, changes in the economic status of the importing countries. Thus, it was recommended that extending the export market to countries beyond the U.S. and EU, would provide greater economic stability. Also, government intervention in matters of price stability, EEC quota, freight subsidy, etc. would be highly beneficial.

3. A larger share of EOU production might be directed to the domestic market, particularly during periods of economic crisis in the export market. The EOU would be responsible for a mass-media marketing effort to increase the popularity of mushrooms in India.

4. The Indian government should impose a quality assurance system, viz. ISO 9000, ISI markings, etc., for export products, such as mushrooms, mushroom products, spawn, etc, as well as for the domestic market, so the industry would be eligible for government grants (APEDA, NHB, etc.).

5. Insufficient low-interest funding had resulted in the termination of EOU projects underway and the insolvency of many established operational units. Urgent action on behalf of government agencies was called for, so as to revive and sustain the viability of many EOU.

6. The overall supply of the EOU should be monitored and kept in balance with export market demand, otherwise the viability of the EOU would be jeopardized.

**STATUS – 2012**

It was proposed that information gleaned from an examination of the changes that have occurred in mushroom production and consumption in the U.S. and India as well as globally at the end of the first decade of the 21st century could be used to forecast the performance of the Indian mushroom industry in the foreseeable future.

**Global Scenario**

Mushroom production and consumption have increased considerably the world over (Figs. 6 & 7). Today, more than 100 countries are commercially cultivating more than 12 edible species, and more and more people are adopting mushrooms as a valuable and tasty health
food. Global mushroom production increased by approximately 67% during 1999-2009 (FAO), even by excluding the unofficial production figures emanating from China (Table 1). And, with this rising world production, the market value of all mushroom species increased from US$10 billion to US$15 billion. Further, the volume of trade in mushrooms also exhibited phenomenal growth during the last 10 years or so. A total of 1.1 million tons of mushrooms valued at US$2.6 billion was exported, of which button and specialty mushrooms represented 0.83 million and 0.25 million tons, respectively, and with market values of US$1.8 billion and US$740 million, respectively. During this period, the number of countries exporting button mushrooms was lower (207) than those exporting specialty mushrooms (215).

Figure 7. World fresh mushroom production (2007). Source: (APEDA, 2007)
Figure 8. World mushroom consumption (2007). Source: (APEDA, 2007)

Table 1. Mushroom and truffle production, 1999 - 2009 (USDA compiled, FAO Stat 2011).

<table>
<thead>
<tr>
<th>Country</th>
<th>1999 (million tons)</th>
<th>2009 (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>2.18</td>
<td>4.68</td>
</tr>
<tr>
<td>United States</td>
<td>0.38</td>
<td>0.37</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.25</td>
<td>0.23</td>
</tr>
<tr>
<td>Poland</td>
<td>0.11</td>
<td>0.17</td>
</tr>
<tr>
<td>India</td>
<td>0.014</td>
<td>0.04</td>
</tr>
<tr>
<td>World</td>
<td>3.89</td>
<td>6.50</td>
</tr>
</tbody>
</table>
The global pattern of mushroom consumption during the last decade remained virtually unchanged. During 2011-12, the major importers of fresh as well as processed button mushrooms were U.S., Germany, Netherlands, U.K., France, Ireland, Italy, Hong Kong and Malaysia. Major importers of processed button mushrooms were Brazil, Italy, Netherlands, Japan and Thailand (Data-UN Comtrade, source-APEDA, 2011). The total quantity of mushrooms imported by the major countries during 2011 approached 0.84 million tons with a market-value of US$2.2 billion (FAO). This figure represented 0.65 million tons of button mushrooms valued at US$1.5 billion and 0.18 million tons of other edible species with a value of US$700 million. Also, countries involved in the import of button mushrooms (347) outnumbered those importing other mushroom species (275).

An analysis of the global trade of mushroom during 2011 revealed an important feature—that the highest share of both exports and imports went to fresh and chilled mushrooms of *Agaricus* and specialty mushrooms. Such an export-import pattern created a formidable challenge to Indian exporters serving the western countries, as it confirmed the changing preference of the consumers, particularly in the G-6 countries, which were the largest consumers of this high-value, low-volume commodity.

**U.S. Scenario**

U.S. data since 1999 showed that annual mushroom production remained at approximately 0.38 million tons up to 2009 when a steady increase occurred in both the volume and sale of *Agaricus*. The sale of all mushrooms in the U.S. during 2011-12 reached almost 900 million pounds with a record value exceeding US$1 billion. There was a 4% increase in volume and 8% increase in the sale of mushrooms during 2011-12 when compared to that of 2010 (Table 2).

On the basis of consumption, in 2011, the U.S. was the leading importer of dried/sliced *Agaricus* mushrooms, 2nd ranked importer of prepared/preserved *Agaricus* other than
with vinegar, 3rd ranked importer of fresh/chilled *Agaricus* and 6th ranked importer of fresh/chilled other mushroom species. The bulk of the fresh mushrooms were imported from Canada, valued at US$110.7, and China, valued at almost US$33 million. This strong preference for fresh mushrooms agreed with the pattern of domestic sales for 2011-12. The sale of fresh *Agaricus* mushroom recorded a 7% growth in volume over the previous year, approaching 771 million pounds, while that of processed mushrooms declined by 13% to 110 million pounds over the previous year. Another feature of U.S. mushroom market in 2011 was the 12% rise in the market value of specialty mushrooms over the previous year. Specialty mushrooms garnered a three-fold higher price over button mushrooms and a price increase of 31 cents over the previous year.

An addition to the U.S. mushroom market in 2011-12 was 32.2 million pounds of certified organic mushrooms, showing a 3% rise in their trade. It comprised 68% *Agaricus*, while specialty mushrooms accounted for the remainder (NASS-USDA, 2012).

**Table 2.** *Agaricus* and specialty mushrooms – sales, price and value in the U.S. during 2009-12 (NASS-USDA, 2012).

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume of Sales (1,000 pounds)</th>
<th>Price per Pound (dollars)</th>
<th>Value of Sales (1,000 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td>792,493</td>
<td>1,170</td>
<td>923,889</td>
</tr>
<tr>
<td>2010-2011</td>
<td>863,762</td>
<td>1,180</td>
<td>1,017,884</td>
</tr>
<tr>
<td>2011-2012</td>
<td>899,928</td>
<td>1,220</td>
<td>1,099,096</td>
</tr>
</tbody>
</table>

In 2011, the value of fresh mushroom exports in the U.S. was US$38.9 million, the bulk of which (US$28.6 million) was supplied to Canada and Japan. Canada was also the largest purchaser of dried mushrooms (US$2.7 million). The U.S. ranked 7th among the 10 major exporting countries of fresh/chilled *Agaricus* mushrooms, although it did not appear in the lists of major exporters of other processed button as well as specialty mushrooms.

**Indian Scenario**

During the last decade or so, mushroom productivity and productivity have increased markedly in India (Fig. 6). Despite this notably increase, with its estimated total annual production of approximately 120,000 tons (Anon., 2011), which is 1.8% of global production, India was still not ranked among the leading mushroom-producing countries. In fact, India slipped from 28th ranked in 1997 to 54th ranked in 2007. The closure of several EOUs during this period, such as M/S Transchem Ltd. Pune, Ponds India Ltd. Ooty, Saptarishi Agro-Industries Ltd. Madras, Teg-Masrado Pvt. Ltd. Chail, Vishal Agritech Products Ltd. Indore, and Dashmesh Haegens Agrotech, Chandigarh, was the major reason why so many countries overtook India in mushroom output.
At the same time, several smaller units producing button mushrooms and catering mostly to the domestic market were established (Table 3.), but these had little impact on the export market. Similarly, the unorganized sector, including those units that functioned as cold storages facilities, produced only for the local market, as their produce could not meet the stringent export standards. Domestic-production facilities and EOU's operating in India today include the following:

Table 3. EOU's and other mushroom companies operating in 2012 (DMR, 2011; personal knowledge).

<table>
<thead>
<tr>
<th>Company</th>
<th>Production Capacity (tons per annum)</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agro-Dutch Foods, Lalru (Punjab)</td>
<td>50,000</td>
<td>EOU</td>
</tr>
<tr>
<td>Flex Foods, Dehradun (U.K.)</td>
<td>2,500</td>
<td>EOU</td>
</tr>
<tr>
<td>Inventa Foods, Hyderabad</td>
<td>4,000</td>
<td>EOU</td>
</tr>
<tr>
<td>Himalaya International, Idar Gujarat</td>
<td>10,000</td>
<td>EOU</td>
</tr>
<tr>
<td>Paonta Sahib (H.P.)</td>
<td>2,000</td>
<td>EOU</td>
</tr>
<tr>
<td>Wakefield Mushrooms, Pune (M.S.)</td>
<td>2,000</td>
<td>Domestic</td>
</tr>
<tr>
<td>Balaji Mushrooms, Baramati (M.S.)</td>
<td>1,500</td>
<td>Domestic</td>
</tr>
<tr>
<td>INKAA Foods, Nalagarh (H.P.)</td>
<td>1,500</td>
<td>Domestic</td>
</tr>
<tr>
<td>S.R. Mushroom Industries, Allahabad</td>
<td>1,500</td>
<td>Domestic</td>
</tr>
</tbody>
</table>

Details of a few of the industries presently functioning as domestic and EOU's of India might be of interest here:

**Agro-Dutch Foods, Lalru (Punjab).** The largest mushroom operation functioning efficiently in India today is M/S Agro-Dutch Foods at Lalru in Punjab. This is an EOU producing 50,000 TPA of button mushrooms, with an average daily production of 125 tons. It has, in fact, attained the status of the largest integrated producer of canned mushrooms in the world, maintaining world-class quality standards for canned product, while marketing a broad range of sizes of canned and frozen mushrooms. Equipped with a 10,000-ton chilling capacity, 200-ton boiler capacity and 10-megawatt power plant, the
unit has successfully maintained the position as the largest climate-controlled mushroom producer in India for approximately the last 14 years.

**Flex Foods, Dehradun, U.K.** Launched in 1990s, this EOU is an integrated climate-controlled and mechanized button mushroom farm with cropping as well as processing units. It has 72 cropping rooms (25 m x 35 m) and eight pasteurization tunnels of 30-ton compost capacity each and produces 4-7 tons of button mushrooms daily. Its processing unit is equipped with a large freeze-drier, the first of its kind in India, and exports most of its produce as freeze-dried buttons.

**S.R. Cannery, Allahabad U.P.** Established in the late 1970s, S.R. Cannery is one of the oldest button mushroom-production units in India. It was originally established with only six insulated air-cooled cropping rooms (14.4 m x 4.8 m x 3.6 m) and a canning facility, but later expanded to 28 climate-controlled cropping rooms and five bulk-pasteurization tunnels to increase its capacity to 60 TPA today.

In recent years, the Mushroom Industry in India has undergone a major transformation with regard to the diversity of mushrooms species under commercial cultivation. Punjab and Haryana, H.P., Delhi-NCR and western U.P., both of which rely primarily on seasonal growing, are the leading producers of the button mushroom (Dhar, 1997). During the last decade, introduction of the indigenous milky white mushroom, *Calocybe indica*, has had a major impact on the mushroom portfolio of India. This mushroom species has a simple cultivation method and a long shelf life, which have gained it strong popularity by growers and consumers alike. Further, its optimal growing temperature of approximately 37 °C is amenable to the prevailing climate in the tropical areas of India, which offers an enormous energy cost savings. Annual production of the milky white mushroom in seasonal farms concentrated in the southern states of Tamil Nadu, Kerala and Karnataka has now been estimated to be nearly 10,000 tons (Krishnamoorthy and Amutha, 2007).

Production of another tropical mushroom, *Volvariella* spp., in the eastern and southern states, particularly Orissa, has spread rampantly as a cottage industry involving spawn production in village huts and outdoor cultivation in coconut groves, mango orchards and bamboo plantations. The per annum production of this species is estimated at approximately 10,000 tons.

The seasonal production of tropical and subtropical species of oyster mushroom in States, such as Tamil Nadu, Karnataka, Kerala, Maharashtra, Andhra Pradesh, Rajasthan, Chhatisgarh, Bihar, Assam, Jharkhand and NEH, as well as the industrial unit, M/s Zuari Agro-Chemicals Ltd. in Goa, has risen to about 15-20,000 TPA. Obviously, the extremely large number of these seasonal units, although each small in size, has had an enormous impact on mushroom output and diversity in India.
It is important to mention that specialty mushrooms can utilize a wide variety of agricultural residues and thus might prove useful in efficiently transforming an estimated 600 million tons of low-value farm waste in India into higher value food products. During the last decade, factors like cheaper prices and local availability of specialty mushrooms have contributed to the increase in the per-capita consumption of mushrooms in India from 20-25 g to 40 g.

Considering the mushroom export market, India has made appreciable advances during 1990s, such that by 1997-98 and through to 2005-06 it surpassed Rs. 569 million in exports.

Figure 11. Export value of fresh, dried and preserved mushrooms/morels to different countries 2007. (Source: APEDA, 2007).

In 2006-07, there was a further increase of 39% in the mushroom export value, eclipsing Rs.1 billion, despite a decline in the export of fresh mushrooms from India. However, in 2011, exports declined and India was ranked 62nd and 58th for fresh Agaricus (US$9,000) and fresh specialty mushrooms (US$111,000), respectively. Yet, India, for the first time, exported mushroom spawn to Nepal (200 kg), U.S. (10 kg) and Singapore (3 kg), but valued at only Rs.10, 265/-. Also, among the 10 major exporting countries, India ranked 10th and 8th in the export of provisionally preserved and dried whole/cuts/sliced/powdered Agaricus mushrooms, respectively. Similarly, for the export of Agaricus (US$31,923,000) as well as other mushrooms preserved other than by vinegar/acetic acid (US$1,309,000), India ranked 6th and 11th, respectively. In the latter two categories, India captured only 4.1% and 0.67%, respectively, of the global market, which admittedly presents a dismal scenario. Hence, much remains to be done to improve the export performance of India in
the coming years. It need not be emphasised that for India to enlarge its export basket, strengthening of the EOUs, so as to enhance the production, productivity and quality of the produce at the most competitive price, is essential to its successful competition with countries like China, Poland, Netherlands etc. To achieve the aforementioned goals, industry, academia, and government agencies, etc. must work hand-in-hand in the immediate future.

India has traditionally had a relatively low rate of mushroom consumption. During the last decade, however, per capita consumption has increased from 25 g to 40 g, and the domestic demand continues to grow at 25% per annum (Hindu Business Line, Aug. 2012). It is projected that the rate of growth will increase further with the increasing availability of fresh mushrooms across the country. However, the lack of price support in the domestic market and the resulting erratic supply and demand are major obstacles to sustained growth. Consumption of specialty mushroom species is still confined to urban centres, although there seems to be a modest increase in their demand. The APEDA import data for 2011 indicated that India ranked 10th with the import of approximately 7 tons of provisionally preserved Agaricus mushrooms valued at US$9,000, and ranked 9th in importing provisionally preserved other mushrooms valued at US$954,000. These data clearly demonstrate that mushroom imports to India occurred at a miniscule level, which agreed with the low-level domestic consumption of mushrooms.

CONCLUSIONS

An analysis of the current global trends in mushroom supply and demand, the present-day preference of the U.S. consumer and the performance of Indian mushroom industry during the last decade disclosed the following:

1. Global production and consumption of mushrooms increased with the increased realisation of the culinary, nutritional and medicinal value of both button and specialty species.

2. Preference for fresh button and specialty mushrooms increased in North America, namely Canada and U.S. Yet, in 2008, the global trade of canned mushrooms was only 460,000 tons and of fresh mushrooms was a mere 30,000 tons. In the 2008-09, however, the U.S. imported processed mushrooms, mostly from Asia, including India, valued at US$108.4 million, and fresh mushrooms valued at US$82.9 million, while imports by Canada declined considerably.

3. During the last decade, overall mushroom production and productivity, including specialty mushrooms, increased moderately in India. Domestic consumption of fresh mushrooms rose by approximately 60%, reaching 40 g per capita. Export, particularly of fresh mushrooms, recently declined, likely owing to closure of several EOUs producing export-quality product. Cost of mushrooms in India exhibited wide fluctuations due to unpredictable demand and supply. There is an overall rising trend in the cost of mushrooms in the domestic market along with other foodstuffs, primarily due to an
increasing cost of labour, raw materials, energy, etc. Aside from price, non-tariff barriers also pose avoidable problems in mushroom exports from India.

4. The Indian Mushroom Industry is in urgent need of remedial measures to improve production, consumption and trade. In order to increase mushroom production for international trade, the revival of closed and abandoned EOUs and construction of new units supported by government incentives and subsidies covering energy costs, interest rates, and canning/packaging are desperately needed. Fresh and processed button mushrooms constituted 95% of the export market for India. In view of the increasing international demand for fresh mushrooms, India must focus on creating the necessary infrastructure for cold-chain transport of fresh and chilled produce to its western customers.

5. The prospect has improved for marketing specialty mushrooms in other countries, such as the U.S. and Japan. The climate in regions of India is conducive to growing a wide variety of specialty mushrooms at a low cost, and so production of these species is likely to increase in both quantity and quality in the coming years. Steps to ready mushrooms for the export market need to be taken now, so India may compete with its strong rivaling neighbour, China. Export of value-added products, such as pickles, sauces, ready-to-eat Indian curries, preserves and candies of different mushroom species, might prove effective in expanding the market for Indian mushrooms, sooner than later.

REFERENCES


