

## Insights into the specialty mushrooms production in China – Key takeaways to Indian farmers

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### ABSTRACT

Mushroom farming in India is now a new way of farming to create circular economy and for doubling the farmers' income. In the last two decades, the research efforts of ICAR-DMR, Solan in collaboration with the research centers under AICRP on mushrooms have contributed significantly to the growth of Indian mushroom industry and standardized several composting and cultivation technologies for different mushrooms. It resulted in significant increase in mushroom production in India from 0.05 million MT in 2000-01 to 0.23 million MT by the year 2020-21. However, mushroom production and consumption in India is still inadequate in comparison to the global trends. Though mushrooms have been aggressively promoted as the super food with many therapeutic benefits, the production of medicinal mushrooms and other specialty mushrooms have not reached to the noticeable level in India. On the other side, China which is the leading global producer and supplier of mushrooms in the world is producing more volume of specialty and medicinal mushrooms and reaching every corner of the globe with its low cost and quality mushroom products. In this paper, we made a comprehensive attempt to describe the production systems in specialty mushrooms for the benefit of Indian mushroom growers. The paper is based on the learning experiences from the International Training Workshop on Edible and Medicinal Mushrooms organized by the Shanghai Academy of Agricultural Sciences, China P.R. The insights presented here will be useful for diversification of the Indian mushroom industry and will also provide a road map for a thoughtful policy intervention to tap the potentiality in mushroom farming.

**Keywords:** Automation, Diversification, Marketing network, Mushroom consumption

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The health challenges raised during the COVID-19 pandemic have sparked the quest for new super foods and revived the idea of nutritional immunology. Mushrooms being rich in vital nutrients, minerals and abundant bio-active compounds have attracted the immunity conscious consumers to build up the foundation of wellness by including mushrooms in their dietary plan (Gupta *et al.*, 2018). Mushroom diet or the *M-diet plan* is the new trending word among the millennial and generation-Z. In developing countries like India, where

there is heavy dependence on cereal diets, mushrooms are one of the vegan friendly protein sources. They are also rich source of nutrients such as iron, vitamin B<sub>12</sub> and vitamin D which are typically found in animal based food products. The significant feature of mushroom cultivation is that it utilizes a wide range of agricultural waste material as growing substrate and converts the waste into a nutritious food. They have low fat content, high fibre and contain all essential amino acids. Among the possible direct medicinal value of mushrooms, the most important ones are anti-

cancer, hypolipidemic, hypocholesterolemic and anti-hypertensive (Sharma and Annepu, 2017).

Mushroom farming created a revived opportunity in indoor agriculture and attracted the unemployed youth and new generation farmers to venture into its production across the country (Shirur and Sharma, 2016). Undoubtedly, mushrooms are the high value agriculture crop with the potential of augmenting income of small and marginal farmers. Mushroom cultivation is a strong means to diversify and strengthen the resilience of farmers. There has been significant increase in production of mushrooms in the last few years, especially of the white button and paddy straw mushrooms in India. However, despite of proven therapeutic and nutraceutical benefits, production of specialty and medicinal mushrooms are not increasing in India. However, China's contribution to the global mushroom production has significantly increased in the last three decades (Singh *et al.*, 2017). The major share in this comes from the specialty mushrooms such as shiitake mushroom, winter mushroom, king oyster mushroom, white jelly mushroom, etc.

In this paper, we made a comprehensive attempt to describe the Chinese production systems in specialty mushrooms such as normal pressure sterilization, flower shiitake production technique, external nutrition bag technology for *Morchella* cultivation, production technology of *Cordyceps militaris* on Chinese tussah silkworm pupae, industrial scale cultivation technology of winter mushroom and king oyster mushroom etc. The information presented here is based on the visits to mushroom industries *viz.* Yinghui Mushroom Factory, Fengke Mushroom Factory, Guangming Mushroom Factory, Lianzhong Mushroom Factory, Xingxiu Mushroom Factory in Fengxian District, Shanghai Province and exposure visits conducted at the Institute of Edible Fungi, Shanghai Academy of Agricultural Sciences (SAAS), Shanghai, China PR. The views expressed by the authors in this paper are purely personal, based on the learning experiences from the International Training

Workshop on Edible and Medicinal Mushrooms organized by the Shanghai Academy of Agricultural Sciences, China P.R.

### **Dynamics of mushroom production in India and China**

Though mushroom production in Asian countries started somewhere between 9<sup>th</sup> to 10<sup>th</sup> century, cultivation of mushrooms is a relatively new phenomenon in India. By the early nineties, production of all types of cultivated mushrooms in India was about 5-7 thousand tons per annum. However, the mushroom industry saw its biggest expansion in the mid-nineties with the introduction of new improved strains in white button mushroom by the Directorate of Mushroom Research, with production going up to 40,000 tonnes and exports increasing dramatically. There has been significant increase in production of mushrooms in the last few years. The country's production in 2010 was 1.00 lakh metric tons, of which button mushroom accounted for about 89% of the total production, followed by oyster (6%), milky (1%) and 4% share of other mushrooms (Sharma *et al.*, 2017). By 2020, the production of mushrooms in India reached to a record level of 2,25,000 MT (Sharma, 2021). From 2010-2020, the mushroom industry in India has registered an average growth rate of 4.3% per annum. White button mushroom (*Agaricus bisporus*), oyster (*Pleurotus* spp.), paddy straw (*Volvariella volvacea*), milky (*Calocybe indica*) and shiitake (*Lentinula edodes*) are the five mushrooms that are under commercial cultivation in India. Punjab, Himachal Pradesh, Haryana, Odisha and Maharashtra are the leading mushroom producing states of India. Development of Indian mushroom industry in the last three decades clearly indicates that white button mushroom is the major edible mushroom that contributes greatly to the national mushroom economy. The well channelized domestic market and bulk production of button mushroom under conventional low cost seasonal sheds in Haryana and Punjab has contributed significantly to this trend. Realizing the money making potential in white button mushroom



*Hypsizygus tessellatus* (Bunapi shimeji)



*Hypsizygus tessellatus* (Buna shimeji)



*Auricularia auricular-judae* (Wood ear fungus)



*Lentinula edodes* (Shiitake)



*Flammulina velutipes* (Winter mushroom)



*Pleurotus eryngii* (King oyster)

Fig. 1. Edible mushrooms under commercial cultivation in China

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production, many commercial units have come up in the recent time.

Similarly, overall mushroom production in China has steadily increased over a period of time. The total mushroom production in China at the beginning of the 21<sup>st</sup> century was about 7.8 million MT. By 2018-19, the production has reached to the level of 37.89 million MT (Singh, 2021). Though China is reported to cultivate more than 60 different mushroom species, about 85% of the total mushroom production is contributed by seven species *viz.*, *Lentinula edodes*, *Auricularia auricula*, *Pleurotus ostreatus*, *Flammulina velutipes*, *Agaricus bisporus*, *Pleurotus eryngii*, *Auricularia polytricha* (Fig. 1). The production of shiitake mushroom has registered a five-fold increase from 2072 MT during 2001 to 10432 MT by 2018 (Singh, 2021). China's success in the development of mushroom industry is contributed by many factors, out of which diversification, automation, promotion through traditional Chinese Medicine

(TCM) system, organizing mushroom fairs, mushroom museums to promote the mushroom culture and consumption, funding and availability of mushrooms at affordable prices are some of the key factors in development and growth of Chinese mushroom industry. The number of species both edible and medicinal mushrooms under cultivation has increased significantly with the beginning of 21<sup>st</sup> century. During the same period, the mushroom industry in India also expanded rapidly and it explored the possibility of growing different mushrooms as per the seasonal variability in different geographical regions. But, still this diversification is limited to the major edible mushrooms, such as white button mushroom in North Western part of India, milky white mushroom in tropical Southern states, paddy straw mushroom in the states of Odisha, Jharkhand and West Bengal; oyster and shiitake mushroom in few pockets of North East India. In order to meet the global production levels, it is essential to explore the species diversity besides exploring the seasonal variability.

**Table 1.** Mushroom industry in India and China – A comparison

| Contents                              | India  | China  |
|---------------------------------------|--|--|
| Industry status                       | Non significant  | 5 <sup>th</sup> largest agri sector  |
| Total mushroom production             | 0.23 million MT  | 38.7 million MT  |
| Farmers engaged                       | 0.5 million  | 25 million   |
| Edible mushrooms under cultivation    | White button, oyster, paddy straw and milky mushrooms  | Shiitake, winter mushroom, shemeji, king oyster, white jelly and white button  |
| Medicinal mushrooms under cultivation | Not at commercial scale  | Reishi, <i>C. militaris</i> , <i>A. blazei</i>   |
| Spawning technology                   | Grain spawn  | Liquid spawn (>75%)  |
| Substrates for mushroom cultivation   | Wheat straw, paddy straw   | Sawdust, corncobs, paddy straw   |
| Promotion system                      | Not a part of ISM  | Priority area in TCM   |
| Key characteristics                   | <ul style="list-style-type: none"> <li>a. Well channelized domestic market for white button mushroom</li> <li>b. Low cost cultivation of white button mushrooms under seasonal conditions</li> <li>c. Operation of large scale commercial production units in white button mushrooms</li> <li>d. Labour intensive</li> </ul> | <ul style="list-style-type: none"> <li>a. Diversification with more specialty mushrooms</li> <li>b. Success in growing the mycorrhizal mushrooms</li> <li>c. Automation and use of small scale machinery</li> <li>d. Corporate finance and community farms</li> <li>e. Public private partnership</li> <li>f. Affordability of mushrooms to common households</li> </ul> |

Presence of robust TCM system in China from thousands of years is helping to promote the mushroom consumption both as food and herbal medicine. TCM system developed several fungus-containing herbal recipes by applying experience and memory. Chinese have included wide range of mushrooms in their regular diet believing that it has several healing properties. The people believe that consuming mushrooms have a detoxification and cleansing effect on the human body. The Chinese recognize six basic types of medicinal mushrooms, according to colour *viz.*, white, red, purple, black, blue and green. The colour codes fit into the TCM system of natural correspondences, which resonate with various diseases like red is for the heart, black is for the kidneys and green is for the liver and gall bladder (Aung, 2005). In ancient times, mushrooms were consumed as decoctions, but in modern TCM, they are consumed as powders, teas, capsules, soups etc.

The mushrooms are often combined with other herbal products to boost the human immunity. Unlike China, India has a unique system of medicine (ISM) in which Ayurveda has described medicinal properties of few mushrooms and wood rotting fungi but it lacks the emphasis on mushrooms in specific. It also resembles in cultural history of India where so many myths surround the edibility of mushrooms (Janakiram *et al.*, 2019). Considering the advances made in the clinical studies and analytical chemistry, there is a need to promote the mushrooms through ISM very extensively to increase their consumption among the Indian folks. Brief comparison of mushroom industries in India and China have been depicted in Table 1.

### Development of mushroom industry in China

It is widely perceived that mushroom consumption in China is very high as it is a part of their food culture and mushrooms are available at a



**Fig. 2.** Mushroom museum in Shanghai (a. Museum building; b. Depiction of mushroom history; c. Display of historical mushroom documents; d. Dried mushroom products; e. Nutraceutical products from mushrooms; f. Demonstration of cultivation history of reishi mushroom)

relatively cheaper price. Even in the later part of 20<sup>th</sup> century, the availability of mushrooms was still scarce and only noble and affluent people had the privilege to consume these delicious foods. However, domestication of edible wild mushrooms and new cultivation technologies developed for mass production resulted in high production and dramatic decline in the prices. Zhang *et al.* (2014) discussed the rapid decline in mushroom prices in China during 1970s with the advancement of production technologies in white jelly fungus and shiitake mushrooms. Before development of industrial scale cultivation techniques for these mushrooms, they were used in traditional medicine preparation and very expensive for common man similar to the present Indian scenario.

Setting up of research institutes engaged in mushroom science and strengthening the manpower has resulted in significant improvement in development of cultivation technologies and genetic improvement of edible and medicinal mushrooms. The technological advancements helped to reduce the production prices and increased the access to mushrooms by supplying at affordable prices. It led to the expansion of domestic industry. Presently, mushrooms are increasingly considered as a substitute for meat products. We had observed that, the mushroom exports from China account for less than 10% from the total domestic production. This signifies how important it is to tap the potential of domestic market with affordable prices to promote and sustain any agri-based industry. We also observed that the local governments are supporting the organization of mushroom product Expos across the major cities of China. In major mushroom producing provinces, local governments are organizing the annual mushroom festivals to promote and brand the local mushroom products. Few big mushroom production units have built privately owned mushroom museums in Shanghai to promote the mushroom diet culture, its traditional history and other mushroom based products (Fig 2). All these factors helped to expand the Chinese mushroom activity as a multi dollar industry.

After decades of development, local and small markets of mushrooms in China have developed into integrated, national-level market centers and several national wholesale markets for mushrooms have been formed. The changes have resulted from improved communication and transportation and large wholesalers at national levels as well as increasing technological knowledge and awareness of mushroom products.

### **Critical observations in speciality mushrooms production in China**

#### **1. External nutritional bag technology for *Morchella* cultivation**

*Morchella* spp. popularly known as morel mushroom is a valuable mycorrhizal mushroom which grows mainly in the high altitude temperate mountainous regions. Its delicacy and rich nutritional properties makes this mushroom very popular across the globe. However, due to its mycorrhizal association, its artificial cultivation becomes difficult and challenges the mycologists across the world. Although different countries and mycologists have cultivated *Morchella* under controlled growing conditions, but the problems of repeatability and low yield could not be solved, so commercial cultivation of *Morchella* has remained a challenge. During the workshop that the authors attended, Chinese artificial cultivation of morel mushrooms was explained by Mr. Tan Fanghe, Associate Research Fellow, Sichuan Academy of Forestry and Technical Director of Chongqing Meizai Industry Co., Ltd (email:tanfanghe668@aliyun.com). The outline of the external nutrition bag technology described during the workshop is being shared with the readers. This technique popularly known as external nutrition bag technique uses the characteristics of weak outside nutrition, imitation of ecological conditions after a certain stage of development and other agronomic management procedures required for fruiting.

**Table 2.** Brief outline for the production of *Morchella* mushrooms using nutrition bag technology.

|                              |   |
|------------------------------|---|
| Choosing planting location   | Close to river beds (dry –wetting cycles)Soil - loam, slightly sandy loam is better   |
| Choosing planting time       | Winter to autumn (November is the best season)Planting temperature of 12 -15 °C (within 5 cm depth of soil)RH of 85-95 %  |
| Ploughing and spawning       | Plough the field to the fine tilth Grain spawn @ 1 kg spawn for 5 m <sup>2</sup> area; Mix thoroughly   |
| Shade net / green house      | North – South direction   |
| Placement of nutritional bag | Sexual development requires a comparable nutrient-poor environment. However, nutrient-poor soil cannot support new mycelia growth without an additional nutrient source to facilitate the growth. Hence, supplying of external nutrition after completion of mycelia run stage is required to force the mycelium to enter into the fruiting stage. The composition of the sterilized external nutrition bag should be- wheat grains (70%); SD (10%); SB (10%); CC (10%) |
| Forcing to fruiting          | Remove the pack and heavy watering till the soil reaches 90% of filed capacity (After 10-15 days from the placement of nutrition bag)<br>Temperature should be raised from 12-15°C to 18-20°C<br>White extrudations will form and can be developed into cone shaped fruit bodies.   |

## 2. Normal pressure sterilization for substrate preparation

Energy cost involved in sterilization of the growing substrate is a major limiting factor in production of the

specialty mushrooms in India. During our visits to different mushroom units, we observed that many of the small scale growers of shiitake, reishi mushroom and white jelly fungus are using the technique of normal pressure sterilization for processing of the



**Fig. 3** Normal pressure sterilization for substrate preparation (a. Substrate filling in cylindrical bags; b. Staking of the substrate bags; c. Tight covering of the substrate; d. Steam generation)

substrate. The substrate is filled in cylindrical bags and stacked together as shown in the Figure 3. The stacked substrate bags are covered with the heat resistant poly sheets. The steam generated by homemade boilers or the steam generated by burning the fire food is pumped to the tightly packed substrate stacks. At normal pressure of the steam, temperature is achieved to 95-100°C. and the temperature is maintained at this level for about 10-12 hrs to achieve the substrate sterilization under normal atmospheric pressure. In order to validate this technology, strains with rapid substrate colonization should be identified in research trials to mitigate the chances of contamination in growing environment. This technique could promote the seasonal cultivation of shiitake and other speciality mushrooms with low investments.

### 3. Flower shiitake production

Shiitake mushroom is the world's most cultivated mushroom. As the production of shiitake is limited in India, it is available in dry form imported from several countries. The dried shiitake mushrooms with thick cap and white cracks on its cap are considered of superior quality and fetches high price. This type of shiitake mushrooms are popularly known as flower

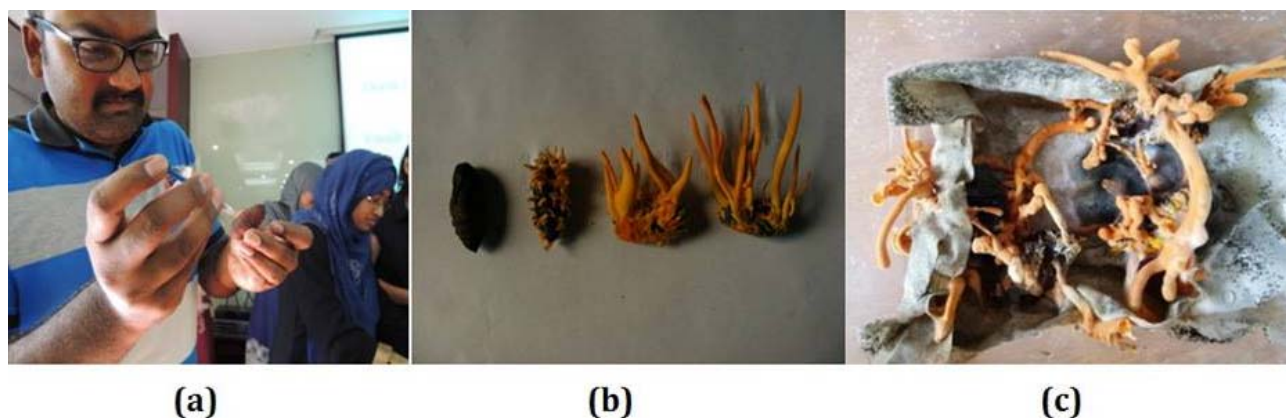
shiitake (Fig 4). In nature/ wood log cultivation, these cracks on the cap surface occur naturally during dry and cold winters. However, in synthetic log cultivation technique, the possibility of developing cracks on the cap surface is very rare as the temperature is maintained at uniform rates throughout the growing period. However, with précised control over the temperature and humidity the cracks can be achieved on the shiitake cap as we had observed in several shiitake production units. To achieve this, diurnal variations needs to be maintained as high humidity and high temperature in daytime and lower humidity and low temperature during night time. This technique works well with the thick fleshed strains of shiitake. Further, the RH levels should be brought down to less than 40% at the time of maturation and reduces the temperature less than 15°C to develop the cracks on the surface of the fruiting body. These diurnal variations should be maintained when the fruiting bodies have reached 2-3 cm in diameter to avoid the production losses due to these management practices.

### 4. Production technology of *Cordyceps militaris* on Chinese tussah silkworm pupae

*Cordyceps* is an entomo-pathogenic fungi that parasitize insects and spiders. This mushroom is a



**Fig. 4.** Cultivation of shiitake in bag log technique (a. Normal fruit bodies; b. Fruit bodies with cracks on the surface)



**Fig. 5.** Cultivation of *C. militaris* on silkworm pupae (a. injection of spore suspension in abdomen of pupae; b. Development of fruit bodies from pupae; c. mature fruit bodies)

potential source of wide range of bio-metabolites which reported to act as a biological response modifier. Realizing its therapeutic benefits, several techniques have been developed under *in vitro* conditions for mass scale multiplication of the fruit bodies. Cultivation of *C. militaris* is generally practiced under *in vitro* conditions using the nutrient solution containing glucose, peptone, yeast extract,  $\text{KH}_2\text{PO}_4$ ,  $\text{MgSO}_4$ , Vit.  $\text{B}_{12}$ , multivitamin and substrate containing the brown rice (Satish *et al.*, 2020). This technique has proved to be successful in cultivation of *C. militaris*. In addition to the existing practice, we observed the production technique of *C. militaris* on silkworm pupae (*Antheraea pernyi*) to achieve the higher bio metabolites in the end product (Fig 5). In this technique, conidial spores of the desired strain are prepared as liquid suspensions in Potato Dextrose Agar medium. The conidial spores were inoculated at 150 rpm in table concentrator in liquid medium at  $25 \pm 2^\circ\text{C}$  for 5-7 days. 100  $\mu\text{L}$  of this spore suspension ( $10^7$  spores/mL) is injected into the silkworm pupae. The inoculated pupae were incubated in sterilized plastic boxes at  $22^\circ\text{C}$  under the 16:8 hours of dark/light control up to three months period maintaining the RH at 60-80%.

### 5. Fruiting management in *Ganoderma* cultivation

*Ganoderma lucidum* popularly known as reishi mushroom is pharmacologically the most important medicinal mushroom in the world. In countries like China and Korea, reishi mushroom is considered as Mushroom of Immortality. Reishi is grown on the saw dust of broad-leaved trees (mango, poplar, coconut, sheesham, etc.). In artificial bag log cultivation technique, the primordia are usually differentiated into one or a few pinheads. If several pinheads arise from a primordium, the fruit bodies which develop from such stripes are very small. So only a strong pinhead is kept and others should be weeded or pruned. This practice has greatly improved the quality of the *Ganoderma* mushrooms. Moreover, it was observed that, primordial initiation occurs slowly in near dark conditions, but intense light causes the stipe to be too long which and this is not a desirable quality standard. Many growers use moderate light with an intensity of illumination of  $\sim 1500$  lux for development of better quality fruiting bodies. The mushroom growers are allowing only one fruit body to develop and after attaining the full maturity, there will be a huge spore production on the single fruiting body. Besides using the mushroom fruit bodies, the growers are also producing the valuable oil from the *Ganoderma* spores collected from these well developed fruiting bodies.



**Bag cultivation in India**



**Bag cultivation in China**

**Fig. 6.** Cultivation of reshi mushroom in bag logs without pruning and with pruning

**6. Industrial scale cultivation of winter mushroom and king oyster mushroom**

Automation is the future of agriculture and Chinese mushroom industry has adopted it in true

sense. Professional mushroom growers as well as small scale farmers use different need based machinery at various stages of mushroom production. Besides saving time, these handy tools and machinery helps in improving the productivity and efficiency at



**(a)**



**(b)**



**(c)**



**(d)**



**Fig.7.** *F. velutipes* cultivation in an automation mode (a. Substrate filling machine; b. PP bottles with filled substrate; c. Staking of substrate filled PP bottles for sterilization; d. Large scale autoclaves for substrate sterilization; e. Liquid spawn facility; f. Inoculation of substrate with liquid spawn; g. Incubation of spawned substrate; h. Scratching of substrate for fruiting initiation; i. LED lighting with blue lights for uniform fruiting; j. Fruiting initiation under controlled growing conditions; k. Shifting of fruiting trays using conveyer system; l. Harvesting of fruiting bunches with uniform weight and quality; m. Packing of fruiting bunches for sale

their farms. The machinery used in automated mushroom industry along with the flow of activities in cultivation of *Flammulina velutipes* is presented below. This can be redesigned and upgraded according to our local conditions so as to save the energy costs and to improve the production efficiency.

The large scale mushroom production units in China adopted the bottle cultivation technology for production of specialty mushrooms mainly *Flammulina velutipes*, *Hypsizygus marmoreus*, *Hypsizygus tessellatus* and *Pleurotus eryngii*. These production units operate with fully automated systems with

specialized equipments for each activity. The use of polypropylene bottles fits perfectly into the mechanized system that runs with automation. Production costs are greatly reduced with automation in substrate sterilization, spawning, cropping and packaging activities. In bottle cultivation, mushrooms are usually allowed to produce only one flush, under short cycle times. Precise control over the growing conditions such as temperature, humidity, CO<sub>2</sub>, light etc. and strict hygiene practices are prerequisites to produce high yield and high quality fruit bodies in bottle cultivation. Automation and environmental control contribute greatly to the stabilization and consistency of this intensive production model (Yamanka, 2017). On the down side, these automated facilities require high capital construction inputs and expensive cultivation machines. The initial set up costs may be too high and energy costs are also high. But gradually, the large scale production units in India can move towards the automation for production of high value mushrooms to increase the export competitiveness of mushroom from India.

### **Key lessons from the workshop**

Many agro industrial products have already received the dividends from the extensive domestic market prevails in Indian sub continent but not by the mushroom industry. We perceive that besides creating awareness, affordability is the need of the hour. The average wage rate in India is about 370 INR/ day and majority of the population below middle class and poor people can't afford to buy mushrooms which are being sold at 400-500 INR per kg with exception to white button mushroom. The mushroom can become an integral part of the Indian cuisine, only when they are available at affordable prices for which low cost cultivation techniques need to be developed. For export purpose, the quality standards need to be set. For instance, the winter mushroom fruiting bunch weighing about 500g, thick flushed shiitake mushrooms with cracks on the surface are readily accepted at the global trade platforms. The ideotype for specialty mushrooms should be fixed accordingly to have a well defined breeding programme. Further, the role of light

intensity and duration has not been studied for many specialty mushrooms for growing under Indian conditions which needs extensive research efforts.

Several financial institutions such as National Horticulture Board (NHB), NABARD, state corporations are extending financial support to mushroom units in India. In future, the mushroom units receiving financial aid from the public funded organizations must be opened for the public visits and knowledge sharing purposes which is not in practice in India. Rather incentivizing individual farmers, financial support should be extended to the hub and spoke models to reduce the cost of cultivation and increase the mushroom production. Priority should be given to those who are ready to take-up new technologies in mushroom cultivation. The Indian System of Medicine is very unique and the therapeutic potential of mushrooms should be integrated with the ISM system for promotion and consumption of mushroom and mushroom related products. As the R&D infrastructure and funding for mushroom industry in India is poor, it is recommended to promote the joint ventures between public research institutes and farmers. Mushroom museums should be built in a public private partnership (PPP) mode to promote mushroom culture, history and cultivation. A special category of forest is planted in all major mushroom cultivation locations in China. Accordingly, specific species and silviculture should be investigated and developed in India to meet the required wood material with less impact on environment. The National Mushroom Market Information Network should be developed and integrated with the e-NAM system. Indian mushroom industry is progressing very rapidly which is evident from the systematic database created by the ICAR-DMR, Solan and its AICRPM network centres in the last two decades. However, the best is yet to come.

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