

INDIA ON THE THRESHOLD OF A NON-GREEN REVOLUTION

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ABSTRACT

India was a late starter as far as mushroom farming is concerned. White button mushroom was grown in the later part of 20th century under National and International Research Projects by FAO, ICAR, CSIR and Agriculture Universities/ Depts. of Horticulture etc. To follow up mushroom research in the country, the ICAR established the National Centre for Mushroom Research & Training (NCMRT) as well as an All India Coordinated Mushroom Improvement Project (AICMIP) in the year 1983 at Solan (HP) now upgraded as the Directorate of Mushroom Research (DMR), and AICRPM with 14 Coordinated and 2 Cooperating Centers in 15 States of the country. Govt. of India, during 1993-97, created 30 Composting Units and 29 Spawn Laboratories in 21 States and spent Rs. 1.36 crores (ca.US \$ 0.27 millions) for training 27,300 potential mushroom growers. Mushroom farming during the last 3 decades or so, has made considerable growth both in terms of seasonal as well as climate controlled growing. The climate controlled farming of button mushroom got a real fillip, under the Govt. EOU scheme to encourage business houses to set-up organized Hi-tech Mushroom Farms as Industrial ventures which together with smaller climate control Farms and the seasonal units have raised the annual production of button mushroom to >0.11 million tons. Among the specialty mushrooms, oyster is leading the group by reaching almost the entire country. Some organized oyster Farms, and a large scale cooperative Farming in NEH States producing over 600 tons of oyster mushrooms p.a. under the auspices of Mushroom Development Foundation, Guwahati, seem to open new vistas in the growth of this mushroom in India. *Volvariella volvacea*, has attained commercial status in Odisha with a low cost cultivation method and spawn made locally on paddy grains in make shift village labs. This way the rural farmers produce over 10,000 tons of paddy straw mushroom in 9 months. *Calocybe indica*, the milky mushroom is a new entrant, but its snow-white color as well as stout & fleshy appearance have helped its fast acceptance and has crossed 10000 tons yearly production figure.

The large variety of indigenous edible species also comprise the mushroom wealth of India, many of which have high export potential. *Morchella* spp. abounding in states of J&K, Himachal and Uttrakhand; *Cordyceps sinensis*/*C. militaris*, the medicinal mushrooms from Himalayas in Uttarakhand and Arunachal Pradesh; *Phellorina inquinans*, *P. herculae* and *Podaxis pistillaris* from the desert state of Rajasthan, shiitake mushrooms *Lentinula edodes* and *L. lateratia*, along with *Auricularia* spp collected and sold in dried form in large quantities in NE region. Edible puffballs (*Lycoperdon*/*Scleroderma* spp), *Termitomyces* spp and *Macrolapiota* sp., are quite common in India. All these species need to be conserved, characterized and utilized for people's welfare and make India's non-green revolution a reality in near future.

Keywords: non-green revolution, climate control, mushroom growth

INTRODUCTION

India is primarily an agricultural country and nearly 70% of its population, including landless and marginal farmers, still depend on farming and allied activities. It is the 7th largest and 2nd most populous nation of the world and has to sustain more than 16% of world's human heads and almost half its size of livestock population, but only with 2.8% of the global land. Possibly, such an enormous pressure on land led some people to list India as a nation which can never feed itself. However, the great nobel laureate Dr. Norman E Borlaug planted the 'seeds' of India's green revolution in early 60s, the first impact of which was felt in 1967-68 when India recorded over 33% rise over its highest production of wheat recorded in 1963-64. The country celebrated its achievement by releasing a postal stamp "Wheat Revolution 1968" as a mark of the beginning of India's green revolution. Soon after, India emerged as the 3rd biggest food grain producer and the 2nd biggest producer both of rice and wheat in the world. However, in view of its population still rising @ 1.6%, the country is seeking the second Green Revolution sooner than later, with an ultimate aim to build-up a sustainable production system capable to

provide not only the staple food but also the functional foods to the toiling masses suffering from hunger and malnutrition, due to the decreasing land-holdings, declining soil-fertility, poverty, lack of employment & opportunities for income generation, and the failing rural economy.

Efforts to tackle such a complex problem of India's agrarian sector are under way for last several decades through a variety of farming/cropping systems, including mushroom farming, which required dovetailing the age-old traditional crop-based technologies with a frontier technology based on microbial conversion of hemi-cellulosic wastes into a nutritious and high-value functional food. Of course, mushroom farming has several additional advantages which make it an ideal secondary occupation capable to solve most of the current problems of Indian agriculture as well as peasants. Mushroom growing is a recycling process done indoors, which does not require arable land or fertile soil, and the waste land unfit for farming can be used to raise a potent cash crop from farm/forest and industrial wastes. Moreover, it gives increased productivity per unit of land, water, energy, labor and time and that too with much less investment. Besides being a fast spinning cash crop, it is also an ideal health food capable to fight malnutrition in general and protein-deficiency in particular. Yet, being a new cropping system for the rural peasants as well as for the un-employed and under-employed people of semi-urban areas of India, it took long time, spread over 5 decades or so, for the adoption and spread across the country. Yet, with efforts of all concerned, it is consoling today that India has slowly but steadily reached today the threshold of a mushroom revolution, which because of its biological capability may better be called as the beginning of a non-green revolution-2014, with a cherished hope that very soon India would be among the front runners of mushroom producing as well as consuming country.

Mushrooms in India

Mushrooms were known well in ancient India. Their habitats were described in olden epics as under: “mDrd Lonta 'kdllkePN=a f'kyhl/kdeAf{kfrxke; dk'B'skq o{kfn"krnqHkonAA”

meaning thereby that, “Mushroom growth appears in moist places on soil, cow-dung, wood, stone-crevices and trees” Also, their references appear in the most ancient scriptures like “*The Sam-Veda*” and the ayurvedic materia medica “*The Charak-Samhita*”. Two Sanskrit verses of the referred ancient epics are reproduced below:

1. “v/; okv/fnflk%l qd kei fo=svku; ** meaning thereby, that “Let the divine intoxicating juice flow here.” This verse has been interpreted by various ancient scholars and contemporary scientists that the sacred nectar mentioned here probably meant “The Soma” or *soma-rasa* used by the Hindu Gods, prepared from a mushroom species, *Amanita muscaria*.

And

2. l iN=d oT; kLrq cg; ks ·U; k'N=tkr; %'khrkihul d=; Up e/kjlx0; l ,o pAA

“explaining thereby that except for toadstools which are forbidden, and those causing sinus diseases, several other species of mushrooms are high quality nutrient, which on eating give sweet and soothing effect.”

Yet, mushroom remained a restricted item for the Vaishnavites (a Hindu religious sect) and some sects of Muslims, because there were some taboos prevalent among the orthodox people against mushroom eating, considering them dirty and unfit for human consumption. Also, there was some fear complex about mushrooms, particularly about the wild mushrooms due to which people avoided them out of disbelief. However, once the cultivated mushrooms became available along with some scientific facts, mushrooms acceptance among educated and elites started increasing slowly but steadily. Yet, their limited availability and high prices versus the low purchasing power of the common man also prevented their popularization among the Indian consumers for quite a long time. As such, the per capita consumption of mushrooms in India remained as low as 20-25 g [1], which in turn restricted the pace of the growth of mushroom producing industry in the country.

Artificial cultivation of mushrooms had a very humble beginning in India by some individual pioneers of the field [2-5], followed by launching of planned scientific programs by various organizations gradually opened the avenues for mushroom

farming as an enterprise suiting both to seasonal as well as commercial growers. Rest is a history of over 50 long years during which the mushroom farming spread across India, and its long journey has already been well traced [6-10], and need not be elaborated here. It would rather be of interest and concern to comprehend the current scenario of 'Mushroom Growth' in India and its expected impact over its national and international trade and also on the nutritional and food security and poverty of its rural and urban populace in coming years.

'Mushroom growth' in India

India is blessed with a varied agro-climate ranging from tropical to sub-tropical and to temperate conditions prevailing in different parts of the country. The prevalent conducive climate together with abundance of farm residues, cheaper labor and demand of protein-rich mushrooms for a primarily vegetarian population, provide ideal situation for mushroom farming in India, with shifting emphasis over temperate, sub-tropical and tropical species in different regions of the country. India currently produces, the temperate mushroom *Agaricus bisporus*, several sub-tropical species of *Pleurotus*, *Hypsizygus ulmarius*, *Lentinula edodes*, and high temperature loving tropical mushrooms *Volvariella volvacea* and *Calocybe indica*. There are several other tropical species of edible and medicinal mushrooms, the growing techniques for which have already been fine-tuned and are ready to be adopted sooner than later [11,12]. This makes a mosaic of produce in the mushroom-basket of Indian entrepreneurs enabling them to meet the varying demands both of national and international consumers at reasonable cost. Button mushroom occupies the largest share of over 3/4th quantity of India's total production, most of which is exported, although there is still ample of scope to further increase it. Mushrooms particularly for the international market, are required to strictly maintain the quality standard, which at least in the case of white button mushrooms of India, is adequately met by the Export Oriented Units (EOU) across the country. Several such units are HAACA compliant as well as FDA approved and a few of them have even started providing organically produced button mushrooms also to foreign buyers. The bulk of the demand of button mushrooms in the domestic market is, however, primarily met by seasonal growers and small commercial farms operating in different regions of the country, which are steadily increasing in number synchronizing with the rising demand and per capita mushroom consumption in the country from 25g to 40g.

As regard to the specialty mushrooms, they are mostly grown by seasonal growers in improvised growing rooms and hence their production capacity is too small to cater to the needs of export market. Moreover, they generally lack in the required hygiene and cleanliness, and hence their produce seldom meets the stringent export quality standards. Moreover, they usually pasteurize their substrate with chemicals which leave residual toxicity in their produce and make them unfit for export. However, during the last few years, commercial units growing oyster as well as milky mushrooms (*Calocybe indica*) have also come up, which are raising good export-level crops and getting favorable response from abroad, and it is hoped that they would soon obtain quality approval from the importing nations, or they would also resort to organic farming of oysters [13]. Similar is the situation with shiitake (*Lentinula edodes*), which is still in its infancy as far as its commercial cultivation is concerned, although its demand exists both inside and outside the country, particularly in Japan. Most of the domestic demands of shiitake are met from its large scale wild collections from Meghalaya, Manipur, Nagaland and adjoining areas [14,15] of NEH India.

The fastest growing and one of the tastiest mushroom is paddy straw mushroom or the chinese mushroom *Volvariella* spp, represented in India by *V. volvacea*, *V. diplasia* and *V. esculenta*, among which *V. volvacea* is the most commonly cultivated species in tropical areas of the country. Although it is cultivated in States like Odisha, Tamil Nadu, West Bengal, Kerala, Manipur, Chhatisgarh and Punjab, yet its farming in Odisha has attained the same status as that of button mushroom in North-Western States of Haryana, Punjab, J&K, Uttrakhand, Himachal, etc. In both the cases, the growing techniques adopted by the growers are based on seasonal as well as low cost methods. Yet, in view of their large scale adoption both by growers and domestic consumers alike, there is an urgent need to introduce at least some cost-effective and simple improvements in their methods to make their farming more profitable and sustainable. Simultaneously, some export oriented *Volvariella* farms adopting modern technology may be set up as Model Farms in Odisha to help and motivate the aspiring growers of the state to adopt EOU for paddy straw mushroom also, so as to capture the market of the countries of South East Asia and others. As far as milky mushroom (*Calocybe indica*) is concerned, it is heartening to note that some commercial units have already come up in peninsular India, particularly in Tamil Nadu and Andhra Pradesh, which are poised to capture the export market for this new Indian delicacy very soon.

Mushroom map in India

In earlier years, mushroom farming in India was almost confined to hills or the foot-hills, since the species then in use was the European mushroom *Agaricus bisporus* which only needed temperate conditions. However, as the climate control became feasible, and also when some subtropical and tropical mushroom species appeared on the scene, mushroom farming activities moved to plain areas also, where availability of raw materials, water, labor and means of communication were better for the entrepreneurs. Yet, for small growers, the local climate dictated the terms and the species got distributed on the pattern of the climatic conditions of the area. However, the climate controlled button mushroom farms were established randomly based on other considerations, like infrastructure, raw materials, marketing and financial support and incentives. Yet, the current overall scenario shows that by the end of the first decade of the 21st century, mushroom farming has spread far and wide across India along with strong R&D infrastructure and basic support services.

R&D infrastructure & services

Soon after the projects launched by FAO, IGADA, CSIR, SAUs and some State Departments of Horticulture, ICAR in the year 1983 established country's nodal research agency viz., the National Centre for Mushroom Research & Training (NCMRT) as well as an All India Coordinated Mushroom Improvement Project (AICMIP) at Solan (H.P.). Again, in the year 2008, the Solan Centre was upgraded as the Directorate of Mushroom Research (DMR), while the AICMIP was enlarged and renamed as All India Coordinated Research Project on Mushroom (AICRPM) with 14 coordinated and 2 cooperating centers covering different climatic zones in 15 States of the country. Earlier, the Govt. 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 of the country, besides an allocation of Rs. 1.36 crores (ca. US\$ 0.27 millions) for training 27,300 potential mushroom growers. This was in addition to the modern facilities created to produce pasteurized short method compost (SMC), casing soil and quality spawn under an International Cooperation for Indo-Dutch Mushroom Project in the year 1988 at 4 places located at Palampur (HP), Srinagar (J&K), Jeolikote (UP) and Bangalore (Karnataka). Further, an integrated Extension Unit "The HAIC Agro R&D Centre" was started in Sonipat district by Govt. of Haryana to serve the mushroom farmers of the area by providing compost, spawn and casing besides hand on training and advisory services. Besides these public sector units, many private spawn units have come up throughout India. A few featured companies listed by Trade India are shown in Table 1 to exhibit their geographical distribution. The number of labs is much higher. The large units mostly produce their own spawn whereas the small/seasonal growers procure spawn from government/private labs.

Button mushroom farms

There are 3 different farm types of button mushroom currently existing in India, viz., seasonal farms, small commercial farms and export oriented farms. The seasonal button mushroom farms are mostly located in North Western India in the plains of Haryana, Punjab, Delhi-NCR, Western U.P. and their adjoining areas; as also in the hills and valleys of Himachal Pradesh, J&K, Uttarakhand, north Bengal, Maharashtra and Tamil Nadu. These farms are operational only during cooler part of the year and their produce serve mostly the local/regional buyers. Over the years, a good number of small commercial button mushroom farms have come up with less than 500 TPA capacity which operate most part of the year and cater to the needs of the domestic market of cities and metros. The third category of button mushroom farms are the (EOU) which are large (over 2000 TPA), most mechanized and computerized units meant to serve the export market. All the EOUs of India are integrated farms, having their own units for composting/casing, growing and processing operations with imported machineries. Some of them prefer to buy their spawn requirements from multinational spawn companies as per the likings of their foreign customers. Although, the number of EOUs in India have been fluctuating due to closure of some old ones and opening of some new ones in the past, but the total yearly mushroom production by the sustaining farms is rising steadily. Verma [8] has listed only five such sustaining EOUs with their annual production figure showing about 0.70 lac tons of fresh mushrooms per year. However, as per current information, 7 EOUs are presently producing 0.75 lac tons of button mushroom per year. The number of domestic commercial units have also risen, but more rapidly and their contribution to the national kitty as well as India's per capita consumption over the last few years are much more. More notable is the fact that it has spread almost to the entire country (Fig.1), and is now well poised to achieve demand-driven vertical growth in the coming years.

Table 1. Some Featured Spawn Lab Companies of India 2014

1.	Microfungi, Kolkota 700046.
2.	Vee Nee Agro, 9, Green Park, Kolkota 700084.
3.	PCR Industries, Cuddalore (TN) 608001.
4.	Jupiter Biotech, Tiruvannamala (TN) 606601.
5.	MycoGroups, ManddaiyurSalai, Thirucharpalli (TN) 620020.
6.	Udhayan Mushroom Farm, Aladhar Kovil Road, Madurai 625107 (TN).
7.	Anand Mushrooms, Palvakkam, Chennai 600041.
8.	ABRM Export, Thirumudi Nagar, Pondicherry 605001.
9.	Daily Mushrooms, Gangapuram P.O., Erode,(T.N.) 638102.
10.	Wonder Mushroom, Ponda Commerce Centre, Ponda, Goa 403105
11.	Konkan Mushrooms, 76,Ponda Commercial Centre, Ponda, Goa 403105.
12.	Arora Mushroom Agency, Mohan Singh Place, C.P., New Delhi 110001.
13.	Swadeshi Enterprises, Model Town, Delhi-110009.
14.	Helin Bio Genesis, Sector-2, NOIDA, (U.P.) 201301.
15.	Jai Agro Industries, Gandhi Dham, Lilashati Nagar, Gandhi Dham, Gujarat 370201.
16.	Ever Green Mushrooms, Opposite J.K.Tower, Ring Road, Surat,Gujarat 394210.
17.	Omark Enterprises, Maruti Nagar, Hyderabad 502032, A.P.
18.	Vinayak Herbal Nutrients Pvt. Ltd. PrasantVihar, Bhubaneshwar (Odisha) 751024.
19.	Katyayni Creation, Cd-314/li P.O. Dhurva, Ranchi 834004 (Jharkhand).
20.	Renaissance Biotech Pvt. Ltd. 88 Police Colony, Anishabad, Patna 800002 (Bihar)

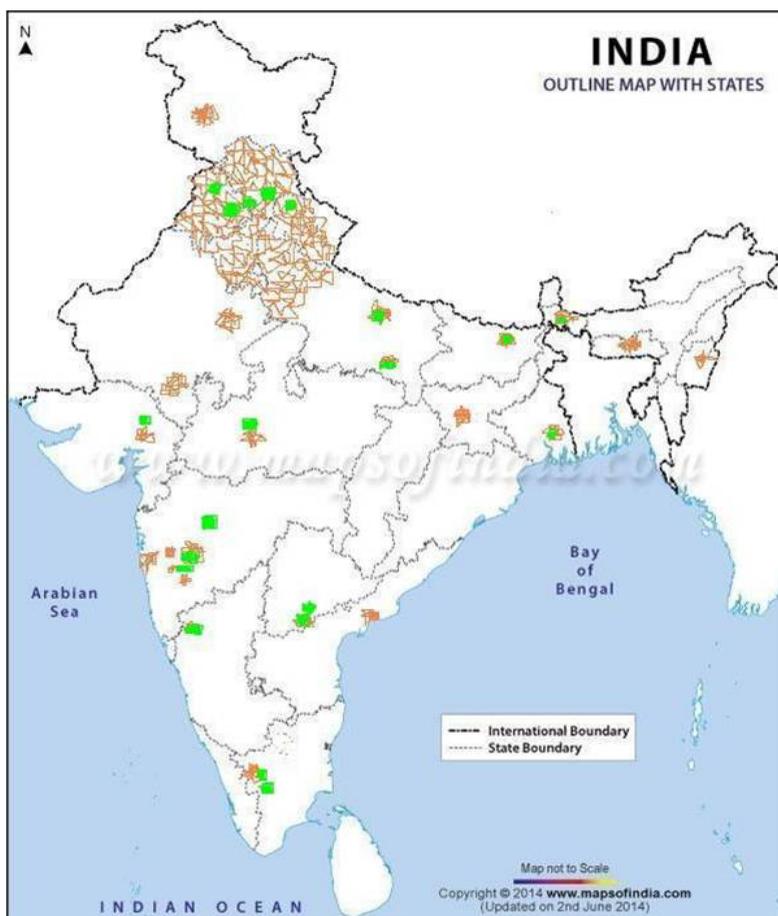


Figure 1. Button Mushroom Seasonal Δ and Commercial Φ farms in India

Specialty mushrooms: Oyster mushrooms including about a dozen species of *Pleurotus* and the Blue oyster *Hypsizygus ulmarius* have been adopted in all States and Union Territories of India and are popularly grown on a variety of substrates. In fact, the largest number of mushroom growers including women-folk belonging to self-help groups (SHGs) and members forming co-operatives, produce this mushroom as a source of livelihood or as profitable enterprises. Yet, taking advantage of the wider adaptability of this mushroom, people are growing its various species in improvised growing houses under seasonal conditions making a modest investment. However, due to increasing consumer demand, recently a few commercial units in southern states, Chhatisgarh and Goa have come up. Also, under the guidance of NGOs like BAIF, Pune; MDF, Gauhati; Divyayan, (RK Mission), Ranchi; Ram Krishna Ashram, Neem Pith, West Bengal; and Pradan, M.P., etc. large scale group farming of oyster mushroom has been adopted in rural & tribal areas under poverty alleviation program. Obviously, covering newer areas, oyster's production is rising fast and are estimated to have crossed 20,000 tons.

The other two specialty mushroom species, which have made considerable impact, are the milky mushroom (*Calocybe indica*) and paddy straw mushroom (*Volvariella* spp). Incidentally, both of these have been promoted by respective State Agricultural Universities, viz., TNAU, Coimbatore and OUAT, Bhubaneswar. While OUAT established a "Centre of Tropical Mushroom Research and Training (CTMRT)" to fulfil the task of popularising tropical mushrooms, particularly the Paddy straw mushroom among the rural youths, the TNAU introduced Milky mushroom, a high temperature loving species *Calocybe indica*. Both these tropical mushrooms have been well accepted and have already exceeded their annual production figures of 10,000 tons each, which are still increasing. Such success of these two mushrooms is obviously due to their tropical nature, but an important factor in their fast spread has been easy availability of their spawn made in improvised rural laboratories "mushrooming" in those areas. Several other mushrooms are in line for adoption by the growers in coming years, the most important one being *Lentinula edodes*, a highly tasteful and potentially medicinal mushroom with great demand abroad, especially in Japan.

Table 2. Some export-oriented and commercial button mushroom farms in India

Name	Approx. Production Capacity (TPA)	Status
Agro-Dutch Foods, Lalru (Punjab)	40,000 (?)	EOU
Flex Foods, Dehradun (UK)	2,500	EOU
Inventa Foods, Hyderabad (AP)	4000	EOU
Premier Mushroom Farms, Medchal (AP)	NA	EOU
Himalayan International, Idar, Gujarat	10000	EOU
Himalayan International, Paonta Sahib (HP)	2000	EOU
Balaji Mushrooms, Baramati (MS)	4000	Domestic
Cambium Biotech Pvt. Ltd., Nasik (MS)	3000	EOU/Domestic
Weikfield Mushrooms, Pune (MS)	3000	Domestic
Inka Foods, Nalagarh (HP)	1500	Domestic
SR Mushroom Industries, Allahabad (UP)	1500	Domestic
Kulkarni Farm Fresh, Belgaum, Karnataka	1000	Domestic
Kodai's West Hill Farms, Kodaikanal (TN)	NA	Domestic
Mushroom Cultivation, Chennai (TN)	NA	Domestic
Vikas Mushroom, Solan (HP)	NA	Domestic
Thakur Mushroom, Solan (HP)	NA	Domestic
Pankaj Internationals, Purnea (Bihar)	200	Domestic
Others (Haryana-3, UP-3, Punjab-5, Maharashtra-5, etc.)	18000	Domestic

Mushroom biodiversity

The production and productivity of a crop can be sustained and enhanced by conserving, improving and utilizing the available genetic resources. India has a rich wild mushroom flora with many of them being edible. Purkayastha and Chandra [14] had listed 261 edible macro-fungi of India. Since then many more edible genera and species have been added [13-16], based on information from local people of the region, but limited efforts for their conservation and utilization at the national level have been made so far. Yet, establishment of a Gene Bank at NRCM, Solan for mushroom germplasm conservation is a welcome effort, which might prove a step in the right direction. Earlier, work on genetic improvement at NRCM led to the release of NCH102, a hybrid variety of *Agaricus bisporus* besides a few single spore isolates. Efforts to domesticate some wild mushrooms are also expected to yield dividends in near future. Till then, attempts may be directed to conserve them *in situ*, as also to train the mushroom collectors for protective harvesting, processing and packaging for export purposes. Among the variety of wild edible species, many have high export potential. *Morchella* spp. abounding in States of J&K, Himachal Pradesh and Uttarakhand are considered as most delicious mushrooms, and till a decade ago, they comprised the highest quantity of dried mushrooms exported from India. Though reported from Shillong also, the high Hills of NEH states of Meghalaya, Arunachal, Nagaland, Manipur and Sikkim are yet to be explored for morels. Same is the status of wild Kabul-Dhingri (*Pleurotus eryngii*) common in border-areas of Kashmir with Afghanistan. In recent years, *Cordyceps sinensis*/*C. militaris*, the medicinal mushrooms collected from Himalayan ranges in Uttarakhand and Arunachal Pradesh have gained much importance and they also need to be protected for survival and sustained growth. Rajasthan, a desert state, has also two excellent wild mushrooms occurring in large quantities in sand dunes. These species are *Phellornia inquinans*, *P. herculae* and *Podaxis pistillaris*, which are still being consumed in nearby States and are yet to be exported. The NEH states are also rich in wild edible fungi, the most important being *Lentinula edodes* and *L. lateratia*, which along with *Auricularia* spp. are collected in quintals and sold in dried form in big Indian cities, and probably outside also. Other delicious mushrooms native to NE region are *Cantherellus cibarius*, *Tricholoma giganteum*, *Termitomyces* spp., *Laccaria amethystea*, *Gomphus floccosus* and *Lactarius queticolor*. In fact, *Termitomyces* spp. are very widely distributed in India and sold in large quantities in local markets of Chhatisgarh, Jharkhand, Odisha, West Bengal and Kerala, and if processed well can be a good export commodity. Two very popular and common edible mushrooms sold in Jharkhand are the i) Puffballs (*Lycoperdon*/*Scleroderma* spp.) and ii) *Macrolapiota* sp., which fetch very high prices in local market due to their taste and excellent aroma. Their occurrence in large quantities make them suitable for export, if properly preserved and packed. Among the medicinal mushrooms, *Ganoderma lucidum* is the lone species, which is ready for commercial farming in India. Its farming method and potent strains, both are available within the country. What is needed is its extension and adoption by the farmers, which may not be far away.

CONCLUSION

From the above review, it is apparent that cultivated and wild edible mushrooms both have received adequate R&D support of national and international agencies as well as good scientific attention during the last 5-6 decades. These have created awareness and interest both amongst the mushroom farmers and the corporate. Also, the consumers have lately shown extra liking for mushroom eating, which has enhanced the mushroom demand and supply in India. In fact, mushroom farming in India today is at the door-step of a "Non-Green Revolution" poised to augment the gains of the green revolution by ensuring nutritional security also in addition to food-security to the toiling masses of this country. What is required is a persistent and focused effort by all dealing with this curious but responsive creature of the third kingdom.

REFERENCES

- [1] Verma RN. (1999). National and International Scenario of Mushroom Production and Trade. Conference on the Mushroom Industry in India - A Decade of Achievements and Future Prospective, Dec. 3, p.5 8, Solan (HP), India.
- [2] Bose SR. (1921). Possibilities of Mushroom Industry in India by its cultivation. *Agric. J.* 16: 643-647.
- [3] Thomas KM *et al.* (1943). Paddy Straw Mushroom. *Indian Farming.* 4: 332-33.
- [4] Bano Z and Srivastava HC. (1962). Studies on the cultivation of *Pleurotus* spp on paddy straw. *J. Food Sci.* 12: 363-365.

- [5] Dhar BL. (1997). Mushroom Industry in India - A View. In: *Advances in Mushroom Biology and Production*, eds. Rai, Dhar and Verma, p.369-378, MSI, Solan (HP), India.
- [6] Verma RN. (1996). Mushroom Industry in India: The Future Prospects. In: *Strategy for Horticulture Development in India*, (eds. Kaul and Dadlani), p. 133-141, DAOC, Government of India, New Delhi, India.
- [7] Verma RN. (2004). Indian Industry: Contribution and Potential of Himachal Pradesh. In: *Advances in Horticulture* (ed. Sharma), p. 139-142, Deep and Deep Publications, Pvt. Ltd., New Delhi, India.
- [8] Verma RN. (2013). Indian mushroom industry - past and present. *Bulletin* 8, World Society for Mushroom Biology and Mushroom Products. p16.
- [9] Thakur MP. (2014). Present status and future prospects of tropical mushroom cultivation in India: A review. *Indian Phytopath.* 67 (2): 113-125.
- [10] Thakur MP and Singh HK. (2014). Advances in the cultivation technology of tropical mushrooms in India. *JNKVV Res J* 48(2): 120-135.
- [11] Mahto Y and Verma RN. (2008). Organic production of oyster mushroom in India. In: *Mus. Biol. Mush Prod.* (eds. Lelley JL and Buswell JA). 6, 212-219.
- [12] Verma RN *et al.* (1995a). Mushroom Flora of North-Eastern Hills. In : *Advances in Horticulture* (eds. KL Chadha and SR Sharma) 13: 329-349, Malhotra Publishing House, New Delhi, India.
- [13] Verma RN and Upadhyay RC. (1995b). Mushroom Genetic Resources in India. In: *Mushroom Genetic Resources for Food and Agriculture* (eds. Labarere and Menini) Global Network on Mushrooms under the aegis of F.A.O. p 153-157.
- [14] Purkayastha RP and Chandra A. (1985). *Manual of Indian Edible Mushrooms*. Today & Tomorrow's Printers and Publishers, New Delhi, pp. 266.
- [15] Bhawani Devi S. (1995). Mushroom Flora of Kerala. In : *Advances in Horticulture* (eds. KL Chadha and SR Sharma) 13: 277-316, Malhotra Publishing House, New Delhi, India.
- [16] Patil BD *et al.* (1995). Mushroom Flora of Maharashtra. In : *Advances in Horticulture* (eds. KL Chadha and SR Sharma) 13: 317-328. Malhotra Publishing House, New Delhi, India.