Working Group Report on Promotion of Mushroom Cultivation in Haryana

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Working Group Report on

Promotion of Mushroom Cultivation in Haryana

Haryana Kisan & Agricultural Costs and Prices Commission

Government of Haryana

2019

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on

Promotion of

Mushroom Cultivation in Haryana

Manjit Singh, VP Sharma, Ajay Singh and Surjeet Singh

2019

Haryana Kisan & Agricultural Costs and Prices Commission
(Government of Haryana)
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Foreword

Diversification in agriculture, value addition and marketing of farm produce are the key factors for economic upliftment of the farmers. Mushroom cultivation is a novel component of Agriculture that can be easily integrated in the farming system to enhance the income of the farmers, or can even be taken up as an independent activity on commercial scale. Land requirement for mushroom cultivation is very less and major input is the agro-waste. In fact, the next revolution in agriculture is going to be based on our ability to effectively recycle the agro-wastes. Productivity and returns in mushroom cultivation are very high because of the vertical nature of its farming. Mushroom cultivation is a venture where we do not just recycle agro-wastes but also produce wealth from the waste. Haryana produces every year about 22 million tonne of wheat and paddy straw. Burning of paddy straw in the fields is a problem in Haryana and adjoining states. It is important that we try to effectively use these straws in a manner that is both economically and ecologically beneficial. Using these straws for mushroom cultivation is one of the practical options.

Accordingly, Haryana Kisan Ayog (now Haryana Kisan & Agricultural Costs and Prices Commission) formed a working group under the Chairmanship of Dr Manjit Singh. The group interacted with all stakeholders and has come out with the report on current status and future approaches for promotion of mushroom activity in Haryana state. I am sure that the report will be of great value to policy makers, entrepreneurs and other stakeholders for promotion of mushroom production as well as its consumption. Greater focus on diversification and secondary agriculture will lead to assured and increased income of our farmers. Mushroom cultivation will prove a boon for small land holders, educated youth and ex-army men/women. We thank all members of working group for their valued efforts in documenting the concept.

(Ramesh Kumar Yadava)

Dr Manjit Singh

Ex-Director, ICAR-
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Vice-President, World Society of Mushroom Biology & Mushroom Products

Preface

Mushrooms are the health food and their demand is going to increase in the coming days due to changing food habits, demand for quality food, urbanisation and globalisation. On the other hand land is shrinking, traditional agriculture is proving to be non-remunerative and farmers want sustainable additional on-farm income. In the last decade Haryana has made good progress in the mushroom production and its nearness to big markets has been an added advantage. Mushroom cultivation has a vast potential due to availability of agro-wastes and manpower in the state. Considering the potential of the crop, Haryana Kisan Ayog (now Haryana Kisan & Agricultural Costs and Prices Commission) vide its order No. HKA/WG17/2018/ 5918 dated: 4th January 2018 constituted a Working Group on 'Promotion of Mushroom Cultivation in Haryana' with the following terms of reference.

1. To analyze the current status of mushroom cultivation in the State such as production, diversification, infrastructure facilities, inputs, policy and technical support and to suggest measures for promotion of mushroom cultivation in the State.
2. To review the present status of training programs and extension facilities for mushroom growers in the State and propose measures for further strengthening of extension facilities in this regard including promotion of mushroom consumption.
3. To assess the costs and returns of mushroom farming, current position of marketing system and infrastructure for mushroom cultivation and suggest measures for further improvement in the marketing system for the benefit of mushroom farmers.
4. To study the problems of mushroom farmers in spawn production technology, compost preparation, spawning, casing and disease control, and to propose appropriate strategies to mitigate them.

5. To study the status of mushroom processing industry in and around the state and future needs including development of standards for mushroom based food products.
6. To study the status of suppliers in and around the state for supply of machinery and other inputs for spawn, compost, cropping, post harvest processing, etc. and measures for further improvement including import of machinery and inputs.
7. To examine the status of research and development for testing/screening of material, development of mushroom varieties, spawn production technology and disease control, post harvest, and to recommend key measures for strengthening of research and development facilities for overall growth of mushroom cultivation in the State.
8. To study the linkages among university, state departments, industry, farmers, market, NGOs and other stakeholders and proposals for their improvement.
9. To propose strategies and policy interventions for adoption and popularization of mushroom cultivation in the State.

The working group interacted with farmers, spawn producers and machinery suppliers, bankers, scientists and other stakeholders and also held in-house discussions. This report is the outcome of these interactions. We hope that the roadmap chalked out based on the present status of mushrooms in the state will help in developing clear policies for promotion of mushroom production in the state and will also help the farmers, entrepreneurs and industrialists to adopt suitable and sustainable approaches.

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Acknowledgements

Haryana Kisan & Agricultural Costs and Prices Commission has brought out this report of Working Group that covers the status and the roadmap for promotion of mushroom cultivation in Haryana. This became possible due to the support of the state government and vision of Dr Ramesh Kumar Yadava, Chairman, Haryana Kisan & Agricultural Costs and Prices Commission. His all-round support and liberal attitude has been a great motivator for all of us.

I am grateful to Dr Manjit Singh Ex-Director ICAR-DMR Solan, Dr VP Sharma Director ICAR-DMR Solan, Dr Ajay Singh Registrar MHU Karnal & Scientist Incharge HAIC Agro R&D Centre, Murthal and Dr Surjeet Singh Ex-Professor (Plant Pathology) CCS HAU Hisar for agreeing to undertake this task and complete it in the stipulated time. Dr RS Dalal, Ex-Member Secretary, Haryana Kisan Ayog provided whole hearted assistance to the working group. Dr Gajender Singh, Research Fellow, Haryana Kisan & Agricultural Costs and Prices Commission worked as nodal officer with the team and provided necessary support for organising the meetings of the group. Dr. OP Toky, Consultant, Haryana Kisan & Agricultural Costs and Prices Commission has been instrumental in arranging meeting of the working group at ICAR-DMR, Solan.

On behalf of the Chairman, I acknowledge the cooperation extended by all the staff members of Haryana Kisan & Agricultural Costs and Prices Commission, HAIC Agro R&D Centre Murthal and ICAR-DMR Solan in conducting different meetings and completing the report. Farmers of Haryana, spawn producers, industrialists involved in developing machinery for mushroom, canners, bankers, scientists, Department of Horticulture, Haryana, MIDH and other stakeholders in and around the state provided valuable inputs during interactions and their support is acknowledged whole heartedly.

July 2019

(R.S. Balyan)

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Executive Summary

Mushrooms are gaining popularity globally and the current annual world production is around 40 million ton. India produces 0.13 million ton mushrooms annually. There are four types of mushrooms under cultivation in India, of which button mushroom accounts for 73% of the production. Haryana accounts for about 15% of button mushroom production in the country [3]. Button mushroom in Haryana is grown both as a seasonal activity and commercial venture. Haryana is the largest seasonal button mushroom producer in the country. The contribution of other mushrooms in the state mushroom production is miniscule.

Haryana produces about 22 million ton of wheat and paddy straw that are primary resource for mushroom cultivation. The button mushroom production in the state in 2017-18 was estimated as 10957 ton about half of which is likely to be from commercial units and the rest from seasonal growers. Most of the seasonal growers are using an old method (long method of compositing) for making substrate for button mushroom cultivation. The committee interacted with all the stake holders. Some of the salient recommendations based on the interactions with stakeholders and discussions held within the group are as below.

The Policy

Department of Agro-waste recycling	Separate department for agro-waste management may be created with three sections viz., in-situ management, ex-situ management and mushrooms
Rationalize electricity rates	Rationalization of electricity rates (=agricultural rates or at par as per cost to the state) and assuring continuous supply
Growers society, membership mandatory for availing any govt benefit	A government supported society of mushroom stakeholders having role in decision making for priority setting and investment on mushroom related activities in state plan. Membership may be mandatory for availing any subsidy or subsequent advice. On-line group of members for regular interaction
Registration of spawn labs; Spawn and product standards	Develop Procedure for registration of spawn labs, naming of cultures used by these labs, seed tags showing name of variety, batch no, date of inoculation, etc. Develop spawn and compost standards
	Establish 3-4 spawn production labs and central units in the state for compost preparation by importing latest technology, especially for Ready to Fruit (RTF) bags of speciality mushrooms
	Need to develop fruit body quality /Food standards including residues. It may be mandatory to display amount of mushroom in the product (dry or wet wt basis) and nutritional components of mushroom products
Special scheme for ex-servicemen	Special scheme for ex-service men on the lines of SCSP Scheme in action plan of Dept of Horticulture. Special training for army men before retirement

Administrative

Short method spawn run compost instead of spawned or long method compost	Promotion of short method of compositing and mushroom diversification; supply of only short method compost under various state plan schemes, provide RTF bags of other mushrooms as well, provide partial subsidy for making huts in 2nd & 3rd year also where subsidy is provided for making hut.

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	Till hubs for short method compost get created, the cost of transport of such compost to far of places may be borne by the government.
	Proper pasteurization of casing at 65° C with 65% moisture. Establishment of spawn labs, compost hubs and machinery hiring centres in at least five locations in the state covering cluster of districts
Income tax clarification	In the light of Inventa vs Dy. Commissioner of Income Tax, Hyderabad, the issue of income from mushroom cultivation as agriculture income may be taken up with centre for issue of general guideline applicable everywhere. State policy is needed for Insurance of sheds.
Centre of Excellence	Establishment of centre of excellence at MKU, Karnal for pilot scale facility demonstration, advanced long term trainings, 3-6 month courses, revision of training manuals, online training and ICT based solutions for the farmers and other stakeholders. Pilot scale projects on Integrating solar energy and water harvesting with mushroom cultivation
Complete restructuring of training modules, online training	Only of those organisations that have infrastructure or preferably pilot scale facilities may impart training to the farmers on the modern technologies. Here too, the period of training may be increased and wherever possible, certificate courses of 3-6 month may be started
	Major focus needed on HRD of the trainers,
Streamline data collection, data as kg/100 kg compost	Data collection and reporting needs streamlining. Data reporting in the form of trays may be discontinued, data may be collected separately for seasonal and commercial growers, and data on other mushrooms may also be collected
Standard reports for availing MIDH subsidy	Department may supply standard designs and reports for better utilisation of Govt schemes and higher productivity
Revise guidelines for MIDH subsidy	Revision of 40 % subsidy under MIDH for 55 lakh to 75 lakh project for establishment of spawn lab or compost unit or cropping unit or any combination thereof instead of integrated unit. This flexibility to set up any one component or more using subsidy on 75 lakh is must to set up viable unit. Subsidy may be given only once.
Promotion of mushroom consumption	Promotion of mushroom consumption by the state through audio visual means, print media, messages on bus stands/ buses, awareness at school level, consumption fares, novel mushroom products, mushroom pickles, introducing mushroom products in mid day meals, etc
Marketing and processing	Collection centres, cold chain facility and promotion of mushroom processing technologies are necessary for better price to the growers.

Research & Development

Review of research and package of practices of CCS HAU, Hisar	Review of research done at HAU, Hisar and revision of package of practices in the university and also website of department of Horticulture.
	Research on engineering aspects like, design of compost/ casing tunnel, fan, rooms etc for our conditions. Develop indigenous machines after importing ones used in Netherlands, China, Korea, etc. Integrated disease management in the wake of label claims.

Promotion of Mushroom Cultivation in Haryana

- A plan to drive the development and sustainability of Mushroom cultivation, consumption, processing and marketing in Haryana

This report focuses on holistic development of mushrooms as a component of farming system as well as an independent venture to address the issues of diversification in agriculture, quality food, health and environment by collaborative and coordinated efforts of farmers, entrepreneurs, marketers, agro-industry, scientists, administrators and the policy makers.

Introduction

The Vedic land of Haryana has been a cradle of Indian culture and civilization. Haryana, traditionally an agrarian society, was carved out of Punjab on 1st November 1966 and has 1.34% (44,212 km^2) of India's land area and supports 2.09% population of the country (2011 census). The State made significant and outstanding achievements in agriculture sector. The Primary contribution towards food security was due to increase in wheat and rice production. The growth in the form of green revolution in 60s started due to availability of high yielding varieties, use of fertilizers and other cultural practices. This was accompanied by overuse of natural resources and fertilizers. After 90s, there was slow down in the growth of agriculture. The answer to this slow down and declining farm incomes, depletion of natural resources and other related problems lies in diversification, proper methods of food storage and transport and value addition. In last few decades horticulture has made greater contribution to tackle these problems.

Sustainable production in farming determines the profitability. Unfortunately the traditional system of agriculture is grossly affected by the vagaries of nature. Let us accept that conventional agriculture has become financially less viable and youth are getting dissatisfied in Haryana's villages. The solution is on-location, off farm employment, which allows families with small land holdings to take up an additional vocation to generate additional income. Hence, there is need to shift towards controlled agriculture and secondary agriculture. Mushroom cultivation is one such vocation which has answers for utilisation of agro-wastes for production of quality food having nutritional and medicinal values. Mushroom cultivation has much wider scope as it can be done seasonally on the farm or commercially throughout the year on small piece of land. Raw materials like straw, chicken manure, gypsum, etc required for its cultivation of mushrooms are easily available in or around the state. There is need for refinement or technology and development of pilot scale models for dissemination of technology and generate awareness about its consumption. The present report focuses on the current status and roadmap for further progress in different avenues for promotion of mushroom production, consumption, processing and marketing in Haryana state.

Mushrooms – Unique in horticulture

Mushrooms (as the "fleshy spore-bearing fruiting body of a fungus") are absolutely unique within horticulture and agriculture. They:

- Are not a plant; are not animal
- Derive their nutrition from organic matter and do not photosynthesize like plants
- Are uniquely nutritious, high in dietary fibre and protein, and contain many important vitamins and minerals

- Are grown under cover, in the dark, in controlled conditions round the year or as seasonal activity in huts

For these reasons, the mushrooms do not have much in common with other products in horticulture (i.e. fruits, vegetables, nuts and so on) other than being a food for human consumption. Mushrooms, like all other fungi, lack chlorophyll and are non-green organisms. They cannot convert solar energy through the process of photosynthesis to organic matter, as green plants do, but they can produce extensive enzymes, which can degrade lignocellulosic materials as nutrition for their growth and fruiting.

The most significant aspect of mushrooms is that these recycle the by-products (wastes) and thus create a pollution-free environment. By blending the advances in basic biological knowledge with that of modern technology, a mushroom-related industry based on utilization of the lignocellulosic waste materials that are abundantly available in rural and urban areas, can have a positive impact on long-term food nutrition, health enhancement, environmental conservation and regeneration, and economic and social benefits. Therefore, the significant impact of mushroom cultivation and mushroom derivatives/products on human welfare in the 21st century could be considered globally as a non-green revolution, but it must be implemented according to locally available substrates, labour, and climatic conditions. Material left after growing mushrooms may be recycled back to soil as manure that can promote organic farming. With increased emphasis on organic farming and integrated farming system, the fungi are going to become important.

Considering the natural resources available in the form of agro-wastes, a predominant rural based economy, prevalence of educated youth looking for suitable vocations, and also the increased demands for quality food/functional foods, there is ample scope for growth of mushroom industry. Considering that our per capita consumption of mushrooms is miniscule (< 0.01 kg) as compared to that of other countries like China (> 20 kg/person/year), there is ample scope for growth of mushroom cultivation and its diversification. Greater effort is needed in generating awareness about its nutritive values, health/medicinal benefits.

What are mushrooms

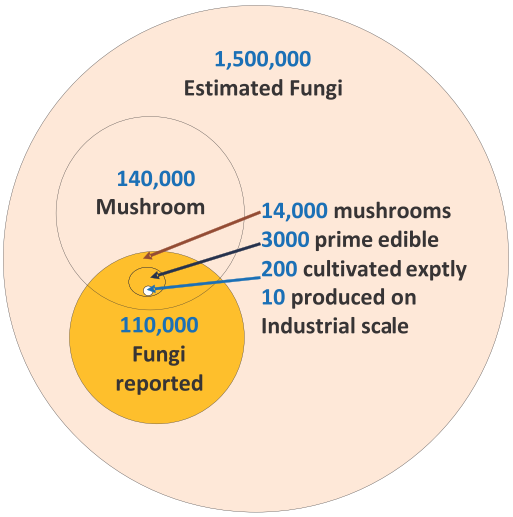
The most extreme use of the term *mushroom* is in reference to just the edible species of genus *Agaricus* (button mushroom). For example, the mushroom industry in the UK and other western countries is nearly 100% dominated by *Agaricus bisporus*. This could lead to the mistaken idea that this is the only species considered as mushroom. Actually, there are thousands of different species of mushrooms. Mushrooms are a group of macrofungi, which have large fruit bodies.

According to one definition, a mushroom is a "macrofungus with a distinctive fruiting body which can be either epigenous or hypogeous and large enough to be seen with the naked eye and to be picked by hand." Therefore, mushrooms need not be Basidiomycetes, nor aerial, nor fleshy, nor edible. Mushrooms can be roughly divided into six categories: edible, inedible, hallucinogenic, medicinal, poisonous, and a miscellaneous category whose properties remain less well defined. The present report is limited to edible cultivated mushrooms.

How many species of mushrooms

Knowledge of numerous new mushroom species has accumulated through time. Out of the 1.5 million estimated fungi species, Hawksworth estimated that 1, 40,000 species may produce fruiting bodies of sufficient size and suitable

structure to be considered as macrofungi (mushrooms). However, less than 1/10th of the fungi or the world (about 1, 10,000) have been described so far. Among these described species, the number of recognized mushroom species has been reported to be about 14,000, which account for 10% of the estimated 140,000 mushroom species. Therefore, there are currently still many unknown species to be discovered. Of the recognized mushroom species, about 7,000 of the species (50%) are considered to possess varying degrees of edibility, and more than 3,000 species from 231 genera are regarded as prime edible mushrooms. But only about 200 of the prime edible mushrooms are experimentally grown, 100 economically cultivated, around 60 commercially cultivated, and 10 produced on an industrial scale in different countries (Fig. 1). Furthermore, of the 14,000 known mushroom species, approx 700 are considered to be safe species with medicinal properties. The number of known poisonous mushrooms approximates 500 species.



Most of the mushrooms are Basidiomycetes and a few are Ascomycetes

Fig. 1: Estimated and actually reported fungi and mushrooms

Why Grow Mushrooms

Wealth from waste

By growing mushroom we generate wealth from the waste as the primary inputs for mushroom cultivation are straws or other agricultural wastes. In fact some of the agro-wastes are environmental issues one of which is burning of paddy straw. Depending upon the type of mushroom, agro-wastes as such, or after mixing with chicken manure, bran, various cakes, etc can be used for cultivation of mushrooms.

Employment generation

Mushroom cultivation generates employment as it is highly labour intensive activity. Mushroom cultivation requires expertise, patience and fineness and is suitable particularly for the youth and women (Fig. 2). In villages and peri- urban areas mushroom cultivation can be source of income and employment generation for women and youth.

Fig. 2: Mushrooms being trimmed for canning

Landless venture

For holistic growth in the country, agriculture has to be engine of growth. However, small Farmers can be unproductive if these continue with conventional agriculture. We have to grow something else to make these productive in sustainable manner. Mushroom cultivation requires much less land than other agricultural activities and any type of small piece of land that has good connectivity and provision of good quality water can be used for growing mushrooms. In addition to more income from limited land, it adds to the social status as it is still a novel activity and different from conventional agriculture.

High profitability and sustainability

It is sustainable activity that gives the returns in short period. Income from mushrooms is much higher than other agricultural activities (Table 1). Income per unit area is a maximum in commercial cultivation. Seasonal cultivation can be integrated in the farming systems and hence the productivity per unit area per annum will be much higher than conventional agriculture. As the cultivation is done in the huts or permanent structures, it is easier to minimise the impact of natural vagaries like drought, unseasonal rains, etc. Cultivation under controlled conditions provides higher sustainability. When we are setting the target of doubling farmers' income, mushroom cultivation can be an important avocation [22, 23].

Table 1: Profitability of mushroom cultivation *vs* other agricultural activities in India

Type of Mushroom farming	Investment (Lakh/ha/annum)	Production (ton/ha)	Water requirement	Annual profit (Rs)
Traditional Agriculture (wheat & Rice)	1. 0	4.5 ton wheat & 5 ton rice	2000 l/kg	0.5 lakh
High-tech poly house	100*	--	500 l/kg?	20 lakh
Seasonal cultivation of mushroom (4-5 Months)	25*	60	40 l/kg	10 lakh
Commercial cultivation	400*	400	25 l/kg	100 lakh

*** Total cost of project, depreciation value used for calculating profit**

Highest protein producers per unit area

Mushrooms are cultivated in tiers under controlled as well as natural conditions. This vertical farming or multi-level farming system provides more growing space than single level systems. The fact that mushrooms don't need light is an added advantage to adopt such under vertical farming system approach. It is generally estimated as equivalent to land that used 4-5 times of the land used under horizontal farming. Vertical farming not only produces more products per unit area but also adds to the convenience, mechanization and quality of the product. Further, it also means efficient use of water and other resources. Because of vertical farming, the mushrooms are the highest protein producers per unit area per unit time when compared to conventional cropping (Table 2).

Table 2. Protein production per ha in mushroom, soya bean, pulses and wheat

Crop	Av yield (dry weight) ton/ ha	Av no of days for crop	Av protein content (%)	Protein/ha/ day (kg)	Protein production relative to mushrooms
Mushroom	40.0*	365	30	32.88	100.0
Soya bean	1.08	120	40	3.60	11.0
Pulses	0.65	90	21	1.52	4.6
Wheat	3.00	155	13	2.52	7.7

* Av yield as fresh mushroom is 400 to 600 Ton Per Annum in a unit put up in one hectare. Yield of 400 TPA is taken here as a conservative estimate. Mushroom has 90% water and hence dry wt yield is 40 ton.

Normally pulses are considered the good source of protein. It can be seen that to produce the same amount of protein mushrooms require 1/20th of the land than required for pulses. To add to this, the quality of protein produced by mushroom and its digestibility is much superior to that in pulses as described in the next section.

SMS- Complete recycling of agro-wastes

Mushrooms are not just wealth from the waste, but these ensure complete recycling of agro-wastes, as material left after growing mushroom (Spent Mushroom Substrate or SMS) is converted into manure, vermi-compost, animal feed, etc. Application of SMS is known to control some of the soil borne diseases. As a soil amendment, spent substrate adds organic matter and structure to the soil. Spent substrate primarily improves soil structure and it does provide a few nutrients. Thus, growing of mushroom as a part of farming system can promote organic farming or minimizing the use of fertilizers (Fig. 3).

There are various other uses of spent mushroom substrate. Spent mushroom substrate is excellent to spread on top of newly seeded lawns. The material provides cover against birds eating the seeds and will hold the water in the soil while the seeds germinate. It can provide a good potting mix for nursery. Two year old SMS can be reused for casing. The experiments are underway at ICAR-DMR Solan to show that the SMS can also be recycled by mixing part of it (up to 20%) to replace the straw in the composting mixture.

SMS has also been used for bioremediation, making briquettes for fuel, for recovery of lignocellulases and allied applications. The end result of each step is additional income generation and complete recycling of agro-waste.

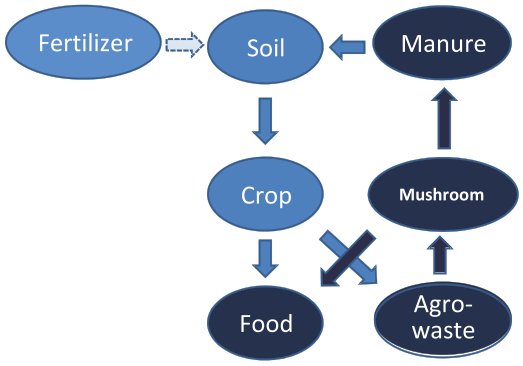


Fig. 3: Complete recycling of agro-wastes by production of food and manure

Quality protein and health benefits

Mushroom are a health food that have quality protein, low sodium, high amount of fibre, medicinal benefits as described in the next section. As described above it is possible to produce quality food from much limited area.

Why Eat Mushrooms

Global population *vs* quality food, Health and environment

The three problems facing the human race are quality food, health and environment. The magnitude of these problems is set to increase as the world's population continues to grow. The 20th century began with a world population of 1.6 billion, and ended with 6.0 billion inhabitants. By 2050 the total world population could reach 10.5 billion, with most of the growth occurring in the less developed countries. The dwindling natural resources are constraining the production systems and these constraints are going to increase with increase in population, changing lifestyles and various degradative processes already affecting the globe. The increasing global population growth may turn out to be a bigger threat to the world's food production and water supplies, health quality, etc, than climate change. In fact, climate change is a function of the increase in population and growing needs of this population.

(a) Health crisis and choice of food

We live in an age of human health crises, especially when considering the leading killer diseases of our time. We have the HIV/AIDS pandemic; various types of cancer, upsurge of hypertension, diabetes, and cardiovascular disorders worldwide. Bovine spongiform encephalopathy (BSE) commonly called Mad-cow disease (a viral disorder affecting the nervous system), foot-and-mouth disease (a highly infectious viral problem afflicting cattle, pigs, sheep, and goats, that caused havoc in Europe), Bird flu (especially H5N1 strain), swine flu and various other zoonotic infections and other disorders (many of which are linked with what we eat) are sending out shock waves that are forcing the world's inhabitants to drastically change their choices of food menus and are shifting from meat towards mushrooms and other vegetarian diets. Human beings are the only species in the world that has figured out how to be in complete control of its food supply. The challenge now is to make sure the food doesn't take control of us. One of the possible reasons of surge in mushroom consumption in China after 2000 was the Severe Acute Respiratory Syndrome in 2002-03.

(b) Mushrooms as health food

Mushrooms are a rich protein source having essential amino-acids and high digestibility. Mushrooms have all the nine essential amino acids required by human being (Fig. 4a).

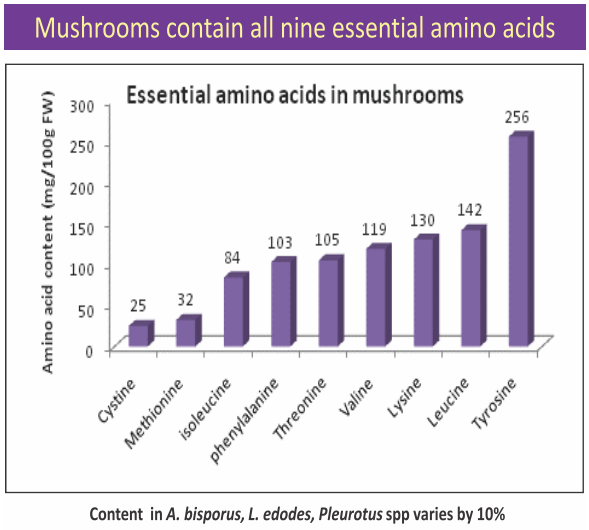


Fig. 4a: Amino acids in mushrooms [1]

Mushrooms have approximately two times more protein than in vegetables and 4-12 times protein than in fruits. Considering that number of people suffer from malnutrition, mushrooms can be an important way to combat this problem. Mushrooms are also good for heart as they have got low fat, no cholesterol, more of unsaturated fatty acids (Fig. 4b) and some of the mushrooms have compounds like lovastatin that is known to lower the cholesterol in the blood. Moreover, mushrooms have low-sodium and high potassium content (Fig. 4c) making it a

suitable food for persons suffering from high blood pressure. These are also rich in minerals (Fig. 4d), which also include copper (heart-protective) and selenium (anti-cancer).

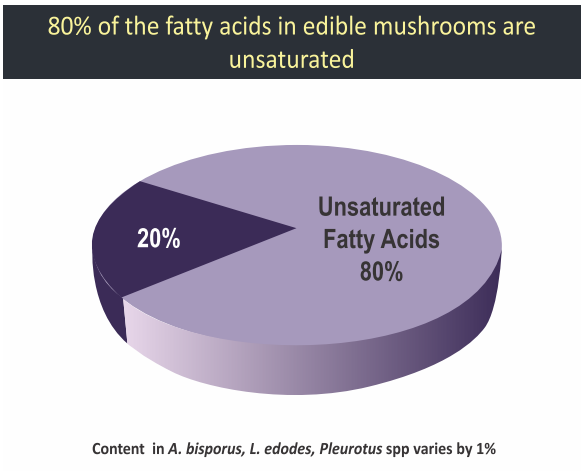


Fig. 4b: Fatty acids in mushrooms [1]

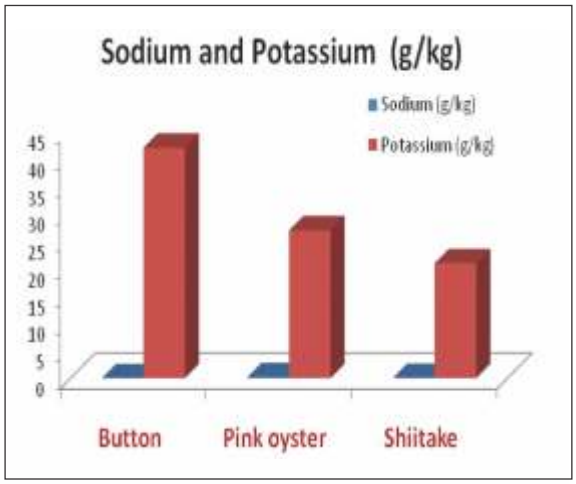


Fig. 4c: Sodium & Potassium in mushrooms [1]

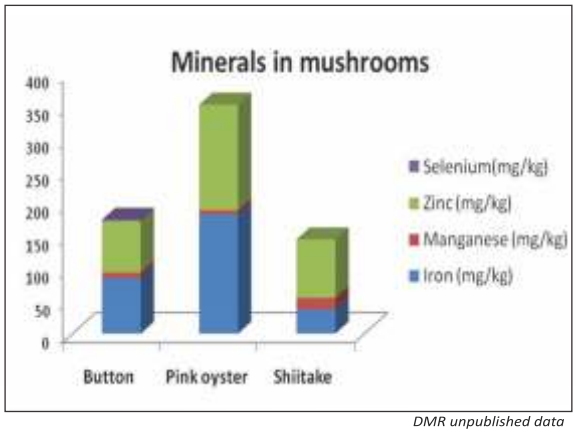


Fig. 4d: Minerals in mushrooms [1]

The mushrooms are also considered delight of diabetics as it is a low calorie food with no starch and has also number of anti-oxidants. These are also rich in fibres and are also a very good source of Vitamins especially vitamin B complex including vitamin B12. Mushrooms are the only vegetarian source of vitamin D. Many of the mushrooms are known to have anti-viral properties and their consumption activates the immune system of the human body.

Compounds from number of mushrooms have found applications in cancer research and numbers of them have been found to reduce the side effects of radio-therapy and chemotherapy (Fig. 5a). There is need to popularize health benefits of mushrooms (Fig. 5b).

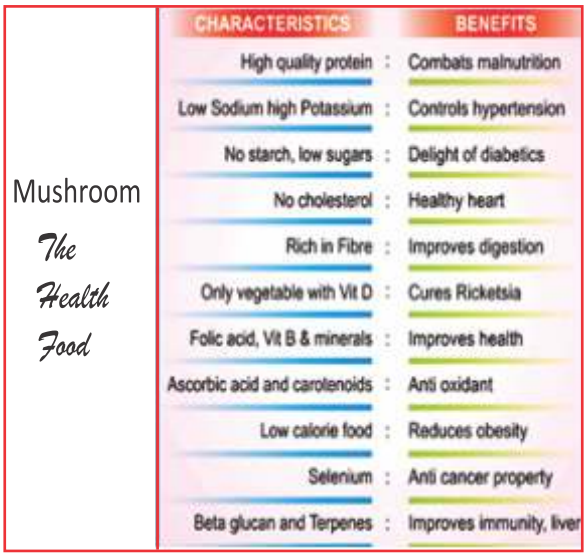


Fig. 5a: Benefits of consuming mushrooms

Fig. 5b: Mushroom promotion at a Dhaba

(c) Mushrooms as dietary supplements/ medicine

Dietary supplements have been described as ingredients obtained from foods, plants and mushrooms that are taken, without further modification, separately from foods for their presumed health-enhancing benefits. These preparations have variety of names like dietary supplements; food supplements, nutritional supplements designer foods, functional foods, nutraceuticals, mycochemicals, phytochemicals, biochemopreventives, tonics etc. There has been rapid increase in trade of mushrooms as supplement and for other medicinal benefits.

Any good product requires a uniform quality from batch to batch that is possible only when a uniform material is produced (which will require specific strains grown under controlled conditions) and is processed by following standard practices. The Newton's third law, that for every action there is equal and opposite reaction, applies everywhere – also when we tend to claim too many benefits of mushrooms. This leads to criticism, especially in the light of variable quality of products labeled identically. Thus, there is need for quality standards for mushroom products to have better market.

Many mushrooms that are used as food also have medicinal value. For example, oyster mushroom is a source of the drug class of statins (Lovastatin) used for lowering cholesterol and so preventing cardiovascular disease. Similarly, shiitake has Lentinan that is considered to have anti tumor, anti thrombosis, anti asthma, antivirus and anti cholesterol activity. Many of these compounds considered to have medicinal value are polysaccharides and their chemical synthesis is not easy. Modern medical practice relies on highly purified pharmaceutical compounds whose activity and toxicity show clear structure-function relationships. Hence there is need for further validation and research on these mushrooms.

Global Scenario

Mushrooms-past records and earliest cultivation

After rains many mushrooms appear from nowhere, especially in grassland, near manure heap, dung or rotting straws/ wood. Mushrooms are fruit bodies of fungi. Fungi are the second largest group of organisms after insects and are neither plants nor animals. Instead, these have been categorized as a different group. Mushrooms have fascinated the human race since times immemorial. Mushrooms have been found in fossilized wood 300 million year old. Almost certainly, prehistoric man used mushrooms collected in the wild as food. In North East and many other parts of India people still collect and consume number of mushrooms. Today we are on the verge of losing that diversity and ethnic knowledge due to changes in agriculture. There is ample evidence that the great early civilizations of the Greeks, Egyptians, Romans, Chinese, and Mexicans prized mushrooms as a delicacy, for their purported therapeutic values, and, in some cases, as treasures in religious rites. Throughout recorded history there are repeated references to the use of mushrooms as food and for medicinal purposes, and it is not surprising that the intentional cultivation of mushrooms had a very early beginning.

China can boast that it was the first to successfully cultivate many popular mushrooms species for example, *Auricularia auricula-judae*

(the estimated date, 600 AD), *Flammulina velutipes* (800-900 AD), *Lentinula edodes* (1000-1100 AD), *Volvariella volvacea* (1700 AD), and *Tremella fuciformis* (1800 AD). Prior to the 1900s, *Agaricus bisporus* (1650 AD in France) was the only major commercially cultivated mushroom species that was not first cultivated in China.

The current global mushroom production

The current production level stands at 40 million ton of edible mushrooms annually (Fig. 6). The production of mushrooms worldwide has been steadily increasing mainly due to contributions from countries, such as China, India, Poland, Hungary, and Vietnam. In contrast, mushroom production in Western European countries, the United States, and Japan, has remained unchanged or even fallen in last decade or so. China especially has witnessed a huge increase in edible mushroom cultivation, and now accounts for over 85% to the total world mushroom production.

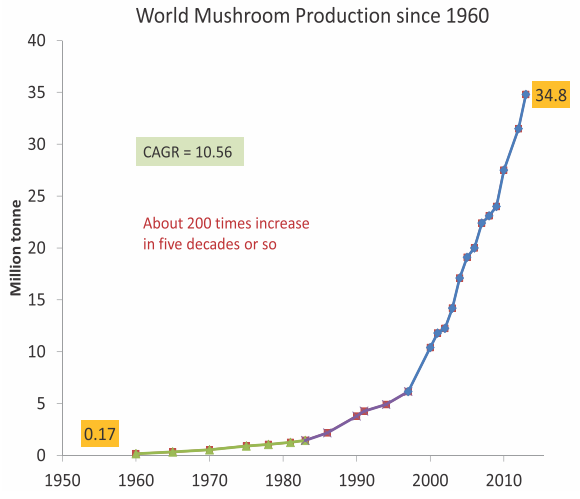


Fig. 6: Global mushroom production since 1960 [2]

Of the 60 different mushrooms cultivated commercially in different parts of the world, six species are grown at industrial scale. The contribution of these six mushrooms to the total world production is 22% *Lentinula* (shiitake), 19% *Pleurotus* spp (oyster), 18% *Auricularia* (wood ear mushroom), 15% *Agaricus* (button), 11% *Flammulina* (winter mushroom) and 5% *Volvariella* (paddy straw mushroom). These six species contribute 90 % to the current world mushroom production (Fig. 7).

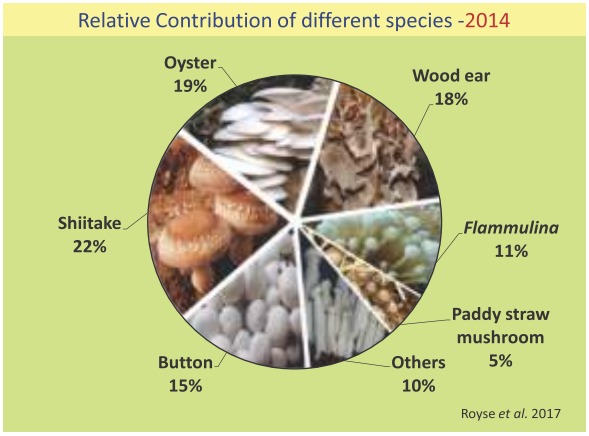


Fig. 7: Contribution of different species to world mushroom production [2]

The growth of mushrooms in China

Since mushroom cultivation is a labour-intensive agro-industrial activity, it has great economic and social impact by generating income and employment for both women and youth, particularly in rural areas in developing countries. Using China as an example, in 1978 the total production of mushrooms in China was only 60,000 tons, which accounted for less than 6% of total world mushroom production. In 2016, however, total production of mushroom in China reached 35.7 million tons and accounted for about 87% of total world mushroom production. Total employment in the mushroom industry in China is 20 million people. The mushroom industry can also have even broader positive spill over, generating complementary employment in areas such as accommodation, restaurant services, etc. Furthermore, it is interesting to note that in some counties in China, with a population of just under 200,000 people, 60% of the population were engaged in mushroom production and management. The local mushroom industry can also be source of revenue for local government.

In China mushrooms are the fifth most important crop next to grain, oil, fruit and vegetable with a separate ministry for edible fungi. The development of the mushroom industry in China can be used as a model for other less-developed countries. This dramatic expansion in mushroom production in China in the last three decades from 1 million tons in 1990 to 35.7 million tons in 2016 is mainly due to the:

1) Strong leadership and initiative of provincial and county governments in grasping cultivation techniques and promoting production. Under these governments, there is usually a special section called "Office of Mushroom Production," which bears responsibility for mushroom research and production and training. The office frequently organizes mushroom farming training courses for farmers.

2) Strong scientific support with the proliferation of mushroom scientists and scholars from various academic institutions in China. It has been estimated the there are more than 500 post-graduate students working for their MSc and PhD degrees in different fields of mushroom biology and applied mushroom biology.

3) Great number of new mushroom species (varieties), both edible and medicinal, have been domesticated and commercialized, e.g., *Pleurotus eryngii, P. ferulae, P. nebrodensis, P. abalonus, P. pulmonarius, P. corucopiae, P. tuber-regium, Flammulina velutipes, Coprinus comatus, Agrocybe chaxingu, Dictophora duplicata, Hypsizygus marmoreus, Macrocybe lobayensis, Hericium erinaceus* mainly for edible, *and Phellinus linteus, Antrodia cinnaomea* (=*Taiwano-fungus camphorates* (niuzhangzhih in Chinese), *Cordyceps militaris, Xylaria nigripes* (wulingshen in Chinese), *Phellinus baumii* (sanghuang in Chinese), mainly for the medicinal purpose in the treatment of diseases.

4) Many innovations of mushroom cultivation technology by talented mushroom farmers. The synthetic log method for cultivation of *Lentinula edodes* was invented by farmer Pan Zhaowan in Gutian County in the Province of Fujian. This has raised the living standards of the farmers.

5) Increase of the domestic market due to the economic boom for the last three decades, which is also a key factor in the expanding cultivation of edible and medicinal mushrooms in China.

Button- a dominant mushroom in West

Production patterns vary according to the geographic region. Although *Agaricus bisporus* is only one of the many edible mushrooms cultivated globally, it has remained the dominant cultivated mushroom in countries of the Western world. In the USA, Canada, Australia, United Kingdom and most other Western European states, the mushroom industry is overwhelmingly focused on this species.

Other species more popular in East

In contrast, mushroom species other than *A. bisporus* are far more popular in East Asian countries. This applies especially to *Lentinula edodes* and species of genus *Pleurotus*, which, based on recent production figures, have already become the two most popular mushrooms grown worldwide. Mushrooms long held popular in Asia (e.g., *Lentinula edodes*, *Flammulina velutipes*, and *Pleurotus* spp.) are now making inroads into Western markets. In Spain, *Pleurotus* spp. and *L. edodes* make up 15% and 5%, respectively, of total mushroom production, and corresponding figures are 0.5% and 1% in the United States.

The Indian Scenario

India is an agrarian based economy even though the share of agriculture towards Country's GDP is on decline. With the variety of agricultural crops grown today, we have achieved food security by producing over 280 million tons of food grain. However, our struggle to achieve nutritional security is still on. In future, the ever-increasing population, depleting agricultural land, changes in environment, water shortage and need for quality food products at competitive rates are going to be important issues.

To meet these challenges and to provide food and nutritional security to our people it is important to diversify. Mushrooms are one such component that not only impart diversification but also help in addressing the problems of quality food, health and environmental related issues. Introduction of such components in the farming system makes the system holistic and more sustainable.

India produces over 600 million tons of crop residues per annum and a major part of it is left out to decompose naturally or burnt *in situ*. This can effectively be utilized to produce high nutritive value food such as mushrooms and spent mushroom substrate can be converted into organic manure/ vermi-compost. Mushroom growing is a highly labour-oriented venture and labour availability is not a constraint in the country. The two factors, that is, availabilities of raw materials and labour make mushroom growing economically profitable in India.

Mushrooms under cultivation in India

At present the four commonly cultivated edible mushrooms in the country **(Fig. 8)** are:

i) Button mushroom (*Agaricus bisporus*)
ii) Oyster mushroom (*Pleurotus* spp.)
iii) Milky mushroom (*Calocybe indica*)
iv) Paddy straw mushroom (*Volvariellavolvacea*)

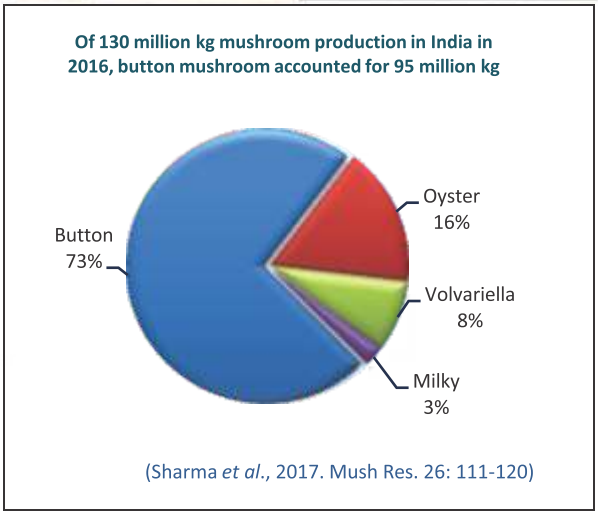


Fig. 8: Different species of mushroom under cultivation in India and their production [1], [3]

Button mushroom is mainly cultivated in North India both under controlled and natural conditions. There are commercial production units in Maharashtra, Gujarat, Andhra Pradesh and other parts of the country. Other three mushrooms in India are cultivated under natural conditions. Of these oyster mushroom is cultivated in all parts of the country but is more popular in NE region. Milky mushroom is mainly cultivated in South India and paddy straw mushroom is cultivated mainly in coastal regions of Odisha (Fig. 9). Cultivation of mushrooms started in India in 70's and there has been rapid growth in last two decades. At present the total mushroom production in our country is about 1.3 lakh tons.

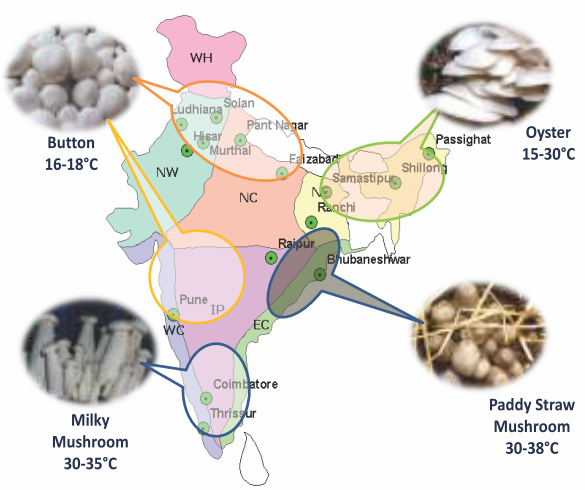


Fig. 9: Mushroom grown in various parts of India [4]

In spite of predominantly tropical and subtropical climates in India, it is the temperate button mushroom that has dominated the mushroom scenario of the country. In India this mushroom accounts for about 3/4th of the total mushroom production in the country and a substantial part of the production comes from commercial units where mushroom is cultivated under controlled conditions. In recent years increasing cost of electricity has increased cost of production in the mushroom industry. During winter season hundreds of seasonal growers do button mushroom production particularly in Northern States targeting big cities like Delhi, Chandigarh, etc. At present both long and short method of making compost for cultivation are used in the country. The seasonal cultivation models need to be refined by providing compost produced by short method to seasonal growers. Strains for hi-tech units have been developed and there is need for strains having wide adaptability, ability to fruit at higher temperature and high carbon dioxide levels for seasonal growers.

We also need to promote other tropical species. For example in oyster mushroom we have species suitable for both temperate and sub-tropical regions. For temperate region *Pleurotus ostreatus, P.florida* (winter strain) and *P.fossulatus* (well known as Kabul dhingri), and *P. eryngii* (king oyster) are the ideal ones. For temperature range of 20-30 °C, varieties like *P. sajor-caju* are suitable. It grows on wide range of agricultural wastes. Its conversion rate or BE i.e., mushroom production in kg/100 kg of the substrate is high (BE up to 100%). Cultivation method is simple and scale neutral (Fig. 10). Moreover, cost of production is low and it can be easily sun dried. Its production by poor people can help to bring them above poverty line and improve their socioeconomic status.

Fig. 10: Cultivation of oyster mushroom [4]

Milky mushroom (*Calcoybe indica*) is indigenous tropical mushroom most suitable for tropical regions and is India's main contribution to the mushroom world. At present this variety is being commercially cultivated in South India (Tamil Nadu, A.P. and Karnataka). Recently its production has started in North India. It grows well in temperature range of 30-35°C accompanied by high humidity and it has excellent keeping quality (Fig.11a). In addition to

Fig. 11a: Milky mushroom cultivation in India [4]

the above, paddy straw mushroom (*Volvariella* spp) is gaining popularity and there has been rapid increase in its production in Odisha. This is cultivated mostly outdoors in coastal areas under shade of trees. Its flavour is excellent and cropping cycle is short. The only drawback is its poor keeping quality (Fig.11b). In some pockets of North East Shiitake is cultivated on very small scale, particularly in areas adjoining Bhutan. Number of mushrooms are collected and consumed in that part of the country by the local inhabitants. Even though, mushrooms are prone to high post harvest losses, the actual losses are relatively low due to their greater demand and awareness among the producers regarding methodology to be adopted to ensure proper disposal in the shortest available time.

Export not a strong option

While a number of the horticultural industries see expanding export markets as strategically important, this is not in the case of mushrooms. Even though labour and other inputs are cheap in India, still India is not the cheapest-cost producer of mushrooms. One of the reasons for this is low productivity (18-20% as compared to 32-35% in West). Any of potential Asian export destination can produce mushrooms at the same or in some cases lower rates. Transport to other destinations involves cost and distance and hence not remunerative. Mushrooms are a relatively highly perishable and short shelf-life product. Efficient and refrigerated export would be costly. The technology to efficiently grow *Agaricus* mushrooms is widely known and so any new export market developed would be quickly cannibalised by opportunistic domestic production. Hence the increased production should be consumed by the domestic Indian market. This will require strong steps towards promotion of mushroom consumption.

Fig. 11b: Paddy straw mushroom cultivation in India [4]

The Haryana Scenario

(As per Terms of Reference)

Mushroom cultivation is an important component of diversification in agriculture in the state. At present India produces less than 1% of world's mushrooms. Haryana has been one of the leading producers of button mushroom in the country and present contribution of the Haryana state to national button mushroom production is around 15 percent [3]. In fact, as per data published in 2017 [3] six states viz., Maharashtra, Punjab, Haryana, Gujarat, Himachal Pradesh and Uttrakhand account for 75% of the production of button mushroom in the country.

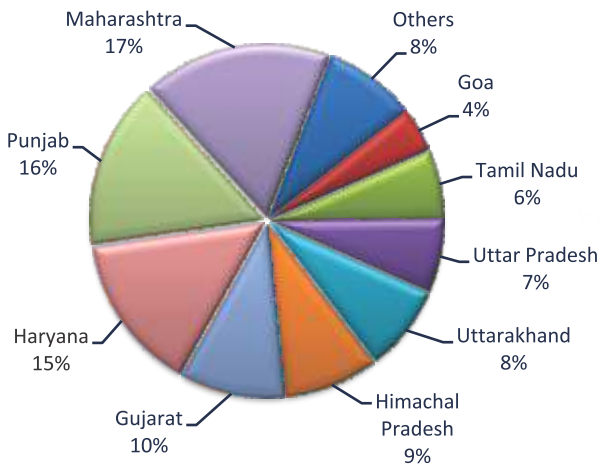


Fig. 12: State-wise button mushroom production during 2016-17 [3]

Terms of Reference (ToR)

Working group constituted by Kisan Ayog under chairmanship of Dr Manjit Singh was assigned nine terms of reference. All the terms (except IX) had two segments, first part dealing with the status and second part with the recommendations. In the following pages firstly the status of different components as per terms of reference has been discussed. The suggestions/ recommendations under various terms have been clubbed together in the last part of the report under term IX dealing with strategies and policy interventions. For continuity of contents the ToR II and III of the original office order have been shifted to Sr No. VI and V. The terms of reference are:

I. To analyze the current status of mushroom cultivation in the State such as production, diversification, infrastructure facilities, inputs, policy and technical support and to suggest measures for promotion of mushroom cultivation in the State.

II. To study the problems of mushroom farmers in spawn production technology, compost preparation, spawning, casing and disease control and to propose appropriate strategies to mitigate them.

III. To study the status of mushroom processing industry in and around the state and future needs including development of standards for mushroom based food products.

IV. To study the status of suppliers in and around the state for supply of machinery and other inputs for spawn, compost, cropping, post harvest processing, etc. and measures for further improvement including import of machinery and inputs.

V. To assess the cost and return of mushroom farming, current position of marketing system and infrastructure for mushroom cultivation and suggest measures for further improvement in the marketing system for the benefit of mushroom farmers.

VI. To review the present status of training programs and extension facilities for mushroom growers in the State and propose measures for further strengthening of extension facilities in this regard including promotion of mushroom consumption.

VII. To examine the status of research and development for testing/screening of material, development of mushroom varieties, spawn production technology and disease control, post harvest and to recommend key measures for strengthening of research and development facilities for overall growth of mushroom cultivation in the State.

VIII. To study the linkages among university, state department, industry, farmers, market, NGOs and other stakeholders and proposals for their improvement.

IX. To propose strategies and policy interventions for adoption and popularization of mushroom cultivation in the State.

ToR-I: Current Status of Mushroom Cultivation in the State

Button mushroom is most commonly cultivated mushroom in the state of Haryana. Farmers cultivate this mushroom as a seasonal activity in winter or as a commercial activity under controlled conditions for round the year production. Two methods of compost production, long and short method, are in use in the state. The production of other mushrooms is so scanty that no data is collected on their production. The overall production in the state and district wise production, which essentially is the production data of button mushroom, is described below:

(i) Status of Production

(a) Status of production in the state

Mushroom cultivation in Haryana started in 1980.Master Jagdev Singh after taking training at Solan in 1980 started button mushroom cultivation in village Badhana in Haryana. Success achieved by him motivated many others and by 1985-86 there were about two dozen units in the village [5]. Total mushroom production in Haryana in 1990-91 as reported by the Department of Horticulture Govt. Haryana (http://hortharyana.gov.in/en/statistical-data) was 850 ton and the production in kg/100 compost, that is, Biological efficiency (BE), was 11.24%. By 1995-96 the production increased to 2410 Ton with BE as 14.6%. In 2000-01 production was 4200 Ton with BE as 17.1% (Fig. 13). Total mushroom production in the state in last 15 years has more than doubled and in 2016-17 the total button mushroom production was 10530 tonnes (Fig. 13). The production is expected to be about 10957 ton in 2017-18 [6].

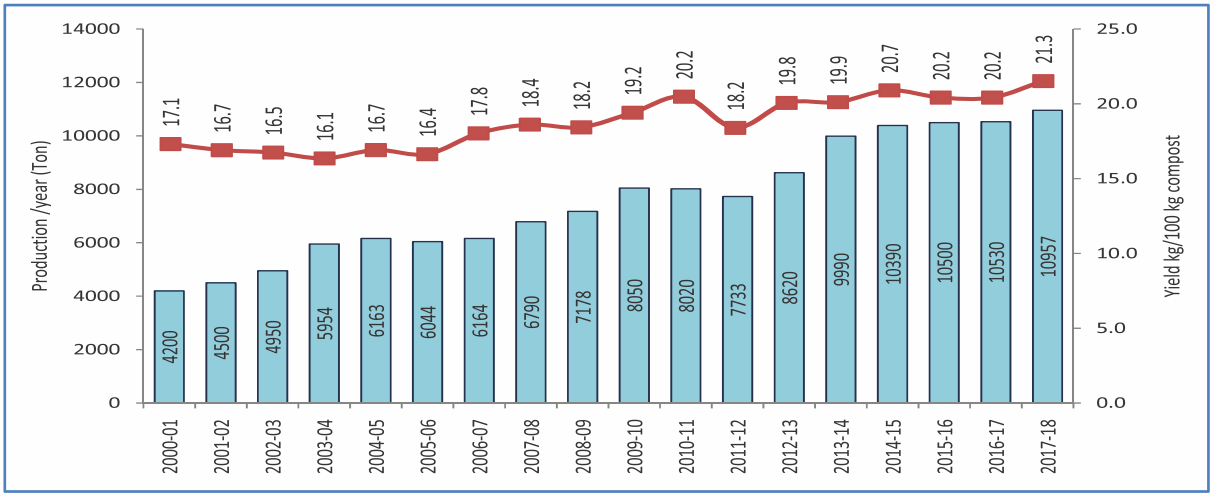


Fig. 13: Mushroom production and productivity in Haryana [6]
(Based on data by Dept of Horticulture, one tray taken = 30 kg)

The estimates for 2017-18 are tentative and hence for subsequent reporting data up to 2016-17 have been considered. The production data seems to refer to only button mushroom as the data was recorded in the form of number of trays. For calculating BE, each tray has been considered equal to 30 kg compost. Even though the production in last 15 years has doubled, but major increase in production appears to be due to expansion in the number of farmers. The productivity that was 17.07 kg/100kg compost in 2000-01, increased to 20.24 kg/100 kg in 2010 and is almost stagnating thereafter (Fig. 13). Yield from 2000 to 2016 has increased 2.5 times (4200 to 10530 ton), whereas the compost production, which indicates increase in area, has increased 2.1 times (24500 ton to 52000 ton approx) in the corresponding period.

(b) District wise production

District wise production of mushroom since 2000 is as given in Table 3. Major contributors are two districts viz., Sonipat and Panipat and other districts located on National Highway 1 (NH-1). Sonipat and Panipat districts accounted for half of the mushroom production of the state in 2016-17 (Fig. 14) and these two districts along with other districts along the NH-1 or around it (Karnal, Kurukshetra, Yamna Nagar,

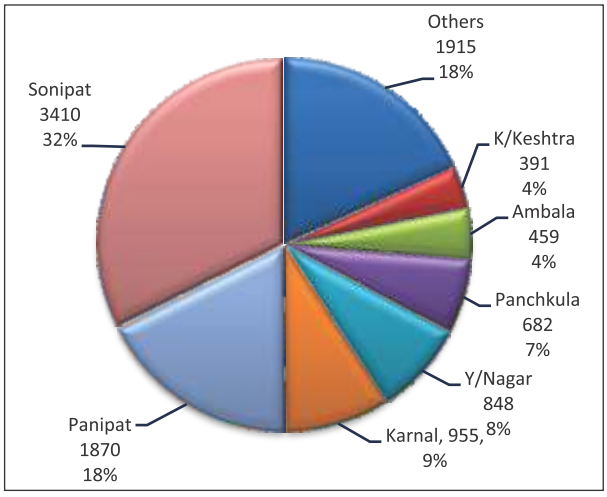


Fig. 14: Mushroom production (2016-17) in different districts of Haryana [6]

Ambala, Panchkula-cluster A) accounted for 82% of the production (Fig. 15). Nearness to markets and transportation seems to have promoted mushroom cultivation in these districts. On the other hand in the cluster of districts (cluster C) on the lower side of map which is also near to Delhi and well connected, there is little or no production.

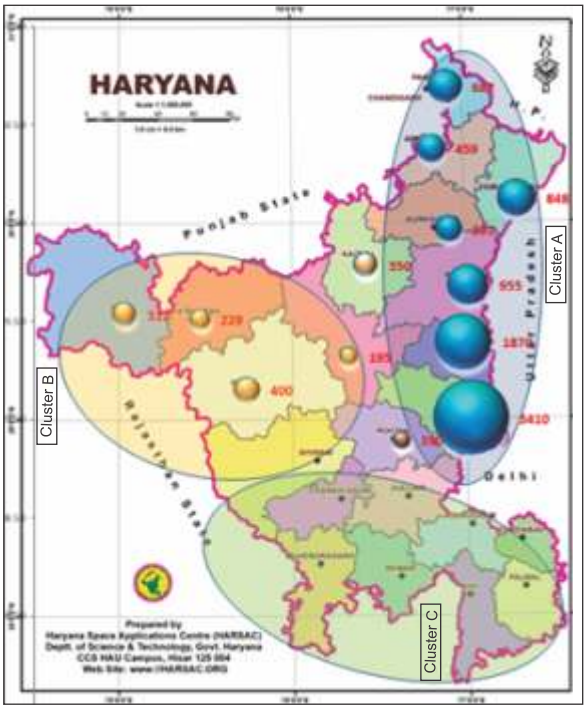


Fig. 15 Geographical distribution of mushroom production in Haryana [6]

Scenario in these districts was not always like this. There was good production in some of these districts a decade ago, but due to rapid urbanisation and high property rates, the production has continuously declined (Table 4). In Gurugram production in the year 2003 was 1095 ton, which decreased to 31 ton in 2016 (-96%). There has been rapid urbanisation in Gurugram (as reflected by 74% increase in population from 2001 to 2011) (Fig. 16, Table 4). Since Haryana surrounds the country's capital city Delhi on three sides (North, West and South) consequently a large area of Haryana is included in the economically-important National Capital Region for the purposes of planning and development.

Table 3: District wise mushroom production in Haryana [6]

District	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18 (P)
Panchkula	55	50	40	50	80	150	396	351	300	155	58	65	620	392	460	682	675
Ambala	140	141	146	144	172	229	90	43	75	85	90	87	74	249	315	459	314
Y/Nagar	180	259	268	330	336	350	445	425	435	453	518	805	850	880	812	848	1005
K/Keshtra	130	130	166	165	197	234	310	415	789	510	515	1050	1100	1015	1064	391	1039
Kaithal	90	115	100	127	145	145	165	275	220	250	280	305	310	350	350	350	360
Karnal	300	320	350	310	385	385	322	471	476	490	495	680	600	670	800	955	945
Panipat	550	600	900	900	1222	1100	1360	1450	1800	1975	1810	1560	1960	1690	1690	1870	1690
Sonipat	1740	1840	2150	2280	2020	2171	2063	2350	2407	2504	2573	2505	3240	3192	3248	3410	3295
Rohtak	210	350	295	340	270	295	350	440	360	362	250	308	21	295	180	190	57
Jhajjar	0	48	75	38	12	42	25	20	24	16	22	37	41	62	44	67	25
Faridabad	30	35	25	11	28	35	28	158	20	42	50	70	35	31	15	21	20
Narnaul	0	0	0	1	3	0	10	5	8	7	3	3	0	5	7	15	19
Rewari	15	7	4	0	1	0	2	2	6	15	26	5	3	16	10	10	13
Gurugram	800	861	1095	1218	775	476	490	341	295	270	312	90	42	248	200	31	550
Bhiwani	10	0	6	2	1	60	70	6	5	98	85	211	250	316	319	0	37
Hisar	120	100	115	110	165	225	130	115	280	380	311	360	380	427	436	400	460
Fatehabad	25	25	30	35	45	60	65	70	65	100	110	100	68	132	140	229	220
Sirsa	15	4	49	7	22	6	4	30	97	28	8	78	125	120	125	312	33
Jind	90	65	140	95	165	190	165	170	162	178	195	200	205	190	193	195	186
Mewat	0	0	0	0	**0**	11	300	41	76	55	6	36	6	35	22	22	11
Palwal	0	0	0	0	**0**	0	0	0	150	47	16	65	60	75	70	73	3
State	**4500**	**4950**	**5954**	**6163**	**6044**	**6164**	**6790**	**7178**	**8050**	**8020**	**7733**	**8620**	**9990**	**10390**	**10500**	**10530**	**10957**

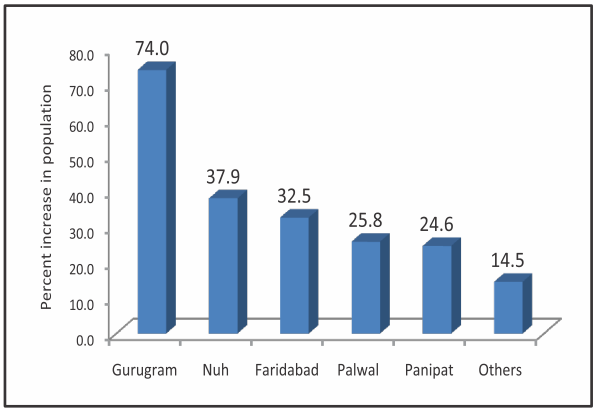


Fig. 16: Percentage increase in population in different districts of Haryana (2001-2011) [7]

The development in these areas has affected agriculture in this region including mushroom cultivation. Sonipat is the leading district in mushroom production since early days (Table 4) and the production continued to grow (+96%). Many of the other districts which were lagging behind in production started producing more mushrooms as a result of which there was 134% increase in the mushroom production in the state from 2001 to 2016 (Table 4).

Table 4: Impact of urbanisation on mushroom production

Districts	Mushroom production (Ton)					% change in production 2001 to 2016	% increase in population (2001 to 2011)
	2001	2003	2008	2013	2016		
Gurgaon	800	1095	341	42	31	- 96%	74.0%
Sonipat	1740	2150	2350	3240	3410	+ 96%	13.4%
State	4500	5954	7178	9990	10530	+ 134%	19.9%

(ii) Status of Diversification

(a) Species-wise production

The contribution of other species to the mushroom production in the state seems to be miniscule, and no data on species wise production is available. The state department of Horticulture seems to collect the data on production of button mushroom alone. Species like oyster and milky are sometimes cultivated by the farmers as seasonal activity when the temperature is in the range of 20-35° C. Many KVKs and other training organisations, like HAIC Murthal, CCS HAU Hisar, do provide spawn of *Pleurotus* or milky mushroom to trainees to promote the growers to learn cultivation of oyster and milky mushroom and majority of them may be attempting to grow these experimentally, but as far as we could learn, there were practically no commercial units or regular growers primarily because of marketing issues. Some growers have experimented with the cultivation of milky mushroom in hot months and obtained good prices. The technology for it needs to be standardized. HAIC in 2017-18 produced about 5% spawn of other species (Table 5) and has also sold 5% spawned compost of other species (Fig 17 a &b).

HAIC Agro R & D Centre regularly conducts experiments on number of mushrooms. Most of the private labs primarily produce spawn of button mushroom only. Hence, spawn production of other mushrooms by HAIC is not true reflection of the production status of other mushrooms in the state. But it does indicate the scope of other mushrooms in the state.

Table 5: Expected share of other species based on spawn production at HAIC Murthal in 2017-18

Species	Spawn produced at HAIC (kg)	Spawning rate (dry straw basis)	Normal BE (dry straw basis)	Adequate for production (Ton)	Expected % share
Button	143030	2%	50%	3575.8	95.93
Oyster	3947	3%	70%	92.1	2.47
Milky	4158	5%	70%	58.2	1.56
Others	112	3%	40%	1.5	0.04
				3727.6	100.0

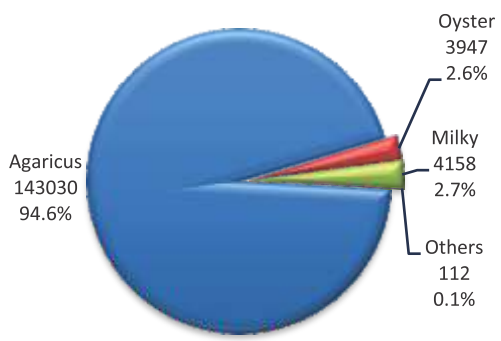


Fig. 17a. Spawn production by HAIC in 2017-18

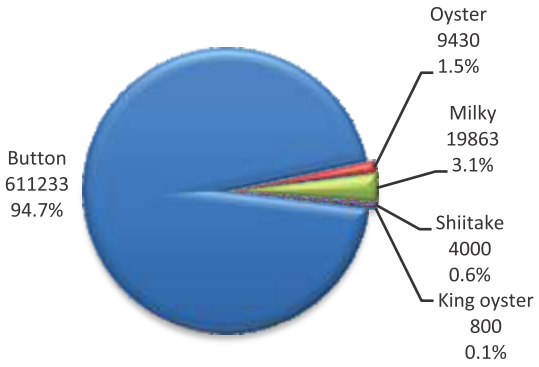


Fig. 17b. Spawned Compost (kg) sold in 2017-18

Many other mushrooms are cultivated in HAIC Murthal (Fig 17c, Table 6) at experimental level like king oyster, shiitake, portabella, paddy straw mushroom, *Ganoderma*, etc. These species are sold in Delhi market at exorbitant rates (Rs 600-1000/kg). But there is no commercial cultivation in the state. There is vast scope of sale of Ready to Fruit Bags (RTF) of oyster mushroom and ICAR-DMR, Solan has standardized the technology (Fig. 18).

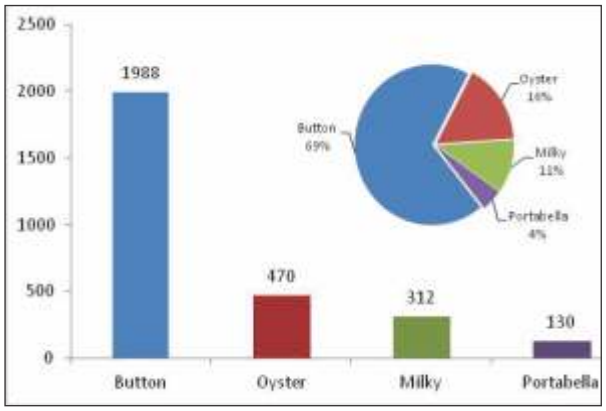


Fig. 17c: Different mushrooms produced and sold in 2017-18 by HAIC, Murthal

Table 6: Mushroom produced (kg) and sold by HAIC, Murthal in 2017-18

Mushroom sold in kg	Button	Oyster	Milky	Porta-bella	Total
Apr-17	80	50	24	0	154
May-17	90	100	58	0	248
Jun-17	70	100	70	0	240
Jul-17	75	98	72	0	245
Aug-17	85	20	57	0	162
Sep-17	90	0	31	0	121
Oct-17	67	0	0	0	67
Nov-17	300	23	0	60	383
Dec-17	350	27	0	40	417
Jan-18	270	8	0	10	288
Feb-18	411	18	0	20	449
Mar-18	100	26	0	0	126
Total	**1988**	**470**	**312**	**130**	**2900**
% share	**69%**	**16%**	**11%**	**4%**	**100%**

The other technologies developed at DMR and can be of help to the farmers are annexed (Annexure 1). It is possible to grow mushrooms as a seasonal activity during different months as mushroom species able to grow at different temperatures are available.

Fig. 18. Ready to fruit bags of oyster mushroom

(b) Climate

In Haryana the monthly average minimum temperature varies from 6.9 to 27.2°C and maximum temperature varies from the 21.4 to 40.2°C (Fig. 19). Only winter months are suitable

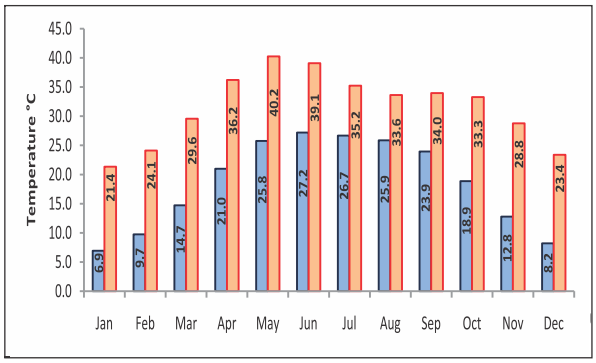


Fig. 19: Monthly averages of maximum and minimum temperature in Haryana [8]

for the cultivation of button mushroom as a seasonal activity. Considering the climatic variations, number of mushrooms can be cultivated under natural conditions in different months. In the table below (Table 7, Fig. 20) we can see that there are number of mushrooms that can be grown in temperature range of above 20°C. The species that can be taken up for seasonal cultivation in different months are as shown in the Fig.20. However, the major focus of farmers in Haryana at present is on button mushroom.

Table 7: Temperature requirement of different species during spawn run and cropping

Sr. No.	Scientific name of Mushroom	Common name	Temperature requirement °C	
			Spawn run	Cropping
1	***Agaricus bisporus***	White button mushroom	23-25	15-17
2	***Pleurotus eryngii***	Kabul Dhingri	20-25	16-18
3	***Lentinula edodes***	Shiitake mushroom	22-25	15-20
4	***P. florida***	Dhingri (Florida)	22-28	15-22
5	***P. flabellatus***	Dhingri (*flabellatus*)	22-28	22-26
6	***P. sajor caju***	Dhingri	22-30	22-26
7	***Auricularia* sp.**	Wood ear mushroom	20-28	20-27
8	***Calocybe indica***	Milky/ Dudhiya mushroom	25-30	30-35
9	***Vovlariella volvacea***	Paddy straw mushroom	30-35	30-38

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agaricus bisporus												
Pleurotus sp.												
Calocybe												
Volvariella sp.												
Auricularia sp.												
Shiitake												
King oyster												

Fig. 20: Species suitable for cultivation in different months in Haryana

(iii) Status of Infrastructure Facilities in the State

Status of institutions and facilities available for promoting mushrooms, in the state is discussed here. Some of the major organisations in the state that are dealing with mushroom are HAIC Agro R&D Centre Murthal, CCS HAU Hisar, MHU Karnal (planning to start courses on mushrooms), NIFTEM, KVKs, Horticulture Training Institute, Karnal, Department of Horticulture and MIDH. ICAR-Directorate of mushroom Research, Solan (HP) is located nearby and is the key institute exclusively working on mushrooms. Number of farmers that have taken training from this institute and have been awarded by ICAR-DMR are as annexed (Annexure 2). Brief description of some of the organizations in the state is as below:

(a) HAIC Agro R&D Centre, Murthal

HAIC Agro R&D Centre at Murthal (Sonipat) was set up as a registered society with Commissioner Secretary, Dept. of Agriculture, Haryana as the Chairman of General Body. Since year 2000 it is managing the project 'Integrated Mushroom Research and Development Project' set up by the Government of Haryana to address the demand of quality spawn, pasteurized compost and casing by mushroom growers of the region. It has a modern spawn laboratory with capacity to produce over 300 ton of spawn per year, two tunnels (each having 25 ton capacity) with production capacity of 2000 ton pasteurized compost per annum, one casing soil pasteurization chamber of approximately 10 MT capacity and a hostel cum guest house for trainees (Fig. 21). In the last decade HAIC has supplied on an average 65 ton spawn, 405 ton compost and 37 ton casing soil per annum. The Centre is also involved in research in collaboration with DCRUST, Murthal & IIT (CRDT) Delhi. Since 2009 it is a part of All India Coordinating Research Programme on Mushroom and is taking up research and evaluation work on regular basis. Number of new mushrooms like Shiitake, king oyster, etc have been cultivated, high yielding varieties of different mushrooms have been evaluated and new cultivation technologies have been tested as a part of multi-location testing.

(b) CCS HAU, Hisar

Chaudhary Charan Singh Haryana Agricultural University (CCS HAU) is a public funded agricultural university located at Hisar. It is one of the biggest agricultural universities in Asia. It is named after India's seventh prime minister, Chaudhary Charan Singh. It was initially a satellite campus of Punjab Agricultural University at Hisar. After formation of Haryana, it was declared as an autonomous institution.

Fig. 21: Aerial view of HAIC Agro Research and Development Centre, Murthal

Facilities for spawn and compost production for mushroom were established under central sector scheme in department of Plant Pathology. As button mushroom has emerged as one of the important crop in the state, many other departments have developed facilities for research and have been working on different aspects of mushroom cultivation, management, processing and marketing. For example entomology department has worked on various insects, mites and nematodes, home science department has worked on various methods of processing and mushroom products/recipes, nutritive value, economics department has worked on cost benefit analysis, etc. As per the information available in Krishikosh, there have been over 60 theses on various aspects of mushroom.

(c) MHU, Karnal

To boost research activities in horticultural crops, Govt. has established Maharana Pratap Horticulture University (MHU) in Karnal. The foundation stone of the Horticulture University was laid out by Hon'ble Union Agriculture Minister and Hon'ble CM Haryana on 6.4.2016. An Act has been passed and Govt. has kept Rs 50 crore during the year 2016-17. The Standing Finance Committee accorded its "In- Principle" approval to the project "Establishment of Horticulture University" at Anjanthali, Karnal with the estimated cost of Rs. 486.59 crore during a period of five year from 2017-18 to 2021-22. An amount of Rs. 6.2 crore have been allocated to University for the development of infrastructure required for growing of mushrooms.

(d) KVKs

There are 18 KVKs in Haryana as per kvk.icar.gov.in. Of these KVKs Ambala and Rewari are with NGOs, KVK Karnal is with NDRI Karnal, KVK Gurgaon is with IARI New Delhi and rest 14 are with CCS HAU Hisar. These are: KVK Bhiwani (Bhiwani), Bhopani (Faridabad), Fatehabad (Fatehabad), Sadalpur (Hisar), Jhajjar (Jhajjar), Pandu Pindara (Jind), Kaithal (Kaithal), Kurukshetra (Kurukshetra), Mahendragarh (Mahendragarh), Ujha (Panipat), Rohtak (Rohtak), Sirsa (Sirsa), Jagdishpur (Sonipat) and Damla (Yamunanagar). The Directorate of Extension Education, HAU started establishing Krishi Gyan Kendra (KGK) (Agricultural Knowledge Centres) in districts of the state of Haryana from 1966. In 1989, the process was remodelled and the new centres have been named as Krishi Vigyan Kendra (Farm Service Centres). One Krishi Vigyan Kendra (KVK) has been established in each district of Haryana. They have been established to spread information about relevant technologies among farmers, rural youth & rural development agencies.

These were established with funding from Indian Council of Agricultural Research. In addition to the fourteen KVKs mentioned above, five KGKs, viz. Ambala (Ambala), Uchani (Karnal), Mandkola (Mewat), Panchkula (Panchkula) and Bawal (Rewari) are now KVKs with CCS HAU thereby making the total number of KVKs with HAU as nineteen.

There is general infrastructure available in all the KVKs for imparting trainings and most of these have been imparting trainings on various aspects of mushrooms (Annexure 3). However, the facilities available for imparting training on modern technology for mushroom cultivation that includes bunkers, tunnels, insulated cropping rooms, etc are not available at KVKs. Hence, training is generally limited to exposure or cultivation of button using long method, or cultivation of oyster and milky mushroom, or on processing of the mushrooms. Some KVKs make up for this deficiency by involving commercial growers of the region having such facilities in the trainings and arranging visits to their farms.

(e) NIFTEM, Kundli, Sonipat

National Institute of Food Technology Entrepreneurship and Management (NIFTEM) located at Kundli in Sonipat District was conceptualized by Government of India as a "One Stop Solution Provider". The institute intends to act as a centre of excellence and an apex world class centre of global standards in the area of food technology and management so as to cater to the needs of various stakeholders such as entrepreneurs, industries, exporters, policy makers, government and existing institutions. The Institute, in addition to excellent infrastructure for studies, has set up various pilot scale facilities which can be highly useful to the growers and industry aiming to process mushrooms and develop various mushroom products. NIFTEM intends to provide incubator services to enable entrepreneurs to develop sustainable businesses. All these facilities will go a long way in promoting mushroom industry in the state. HAIC has developed good linkages with this organisation and trainees are regularly sent for an exposure visit. NIFTEM has a pivotal role in developing food standards, quality, accreditation and certification; keeping a repository of international & national standards and also advising the Government on matters related to international food standards.

(f) Department of Horticulture

Department of Horticulture has network of officers at district and block level that help in dissemination of technologies and collection of data on various horticultural crops including mushroom. The team is headed by Director General, Horticulture. Prior to 2005-06, the horticulture programmes were implemented with the staff strength of around 99 personals. For the proper implementation of new schemes like NHM and MI, State Government sanctioned 48 new technical posts viz., one Joint Director Horticulture, two Deputy Directors, five specialists at head quarter and Assistant Project Officers in each NHM district. The APO assists the DHO for proper implementation and follow of the schemes. Horticulture Department was bifurcated from Agriculture Department into new department in the Sept. 1990. The Directorate of the Department is located in Udhyan Bhawan, Sector-21, Panchkula and has 21 district offices and 25 Government Garden & Nurseries across the State. These offices provide all the extension services in the field of horticulture including those related to mushrooms.

(g) HTI, Karnal

Horticulture Training Institute (HTI) was established in 1998 under the aegis of Department of Horticulture, Government of Haryana in AHRD project of World Bank. It is situated on National Highway No. 1, in village Uchani, district Karnal. It was initiated to cater the needs for capacity building in the field of horticulture. The institute takes up various activities such as training programmes, demonstration, study tours, exposure visits, consultancy, production of quality planting material and horticulture education.

HTI has a well furnished hostel that has twenty four rooms with attached bathroom and fully furnished two VIP rooms. The institute has a well equipped food processing lab. Short duration practical course for women farmers are conducted in this lab. HTI covers diverse areas of horticulture as can be seen in the annual report 2014-15 [9] where, in all, seventy one training programmes were organized, three of which were on mushroom production technology. The trainings on mushroom are more for awareness generation as hi-tech facilities for cultivation of mushrooms that can be used for demonstration during training are not available at the institute.

(h) Mission for Integrated Development of Horticulture (MIDH)

MIDH is a Centrally Sponsored Scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. Government of India (GOI) and the states except the states in North East and Himalayas contribute in this programme. It is a continuing Central Plan Scheme (Sharing Basis). The scheme in the state of Haryana at present is being headed by Dr B.S. Sehrawat, Mission Director and it was started in the year 2005-06 on sharing pattern of 85:15 (GOI: State). In 2015-16 sharing pattern of MIDH was changed to 60:40 (GoI : State). There is provision of 40% back ended subsidy for setting up spawn lab, compost unit and cropping rooms for mushrooms.

(iv) Status of resources related to mushroom farming

Prerequisite of mushroom cultivation is availability of raw materials/ agro-wastes, manpower, water, right climate (for seasonal cultivation) and electricity (for round the year mushroom production) and other resources like bran, cakes, gypsum, fertilizers, etc. The requirements for cultivating mushroom include availability of seed which is referred as spawn, good quality compost/ substrate for cultivation, appropriate cultivation technology and marketing infrastructure. In the following pages the scenario of resources available in the state will be described.

(a) Status of agro-wastes in Haryana

Haryana is traditionally an agrarian society (owner-cultivator farmers). Principal crops are wheat, rice, sugarcane, cotton, Bajra, mustard, sunflower. Data on agro-wastes as such is not available and has been estimated by taking average of the production of grains/seeds of different crops for the year 2014, 15 and 16 and multiply with value based on grain: stover ratio/ harvest index (Table 8). About 80 percent of the crop residues are from cereals (Fig. 22). Wheat and rice are the major contributors (Fig. 23). Haryana produces about 22 million ton of wheat and paddy straw.

Table 8: Production of different crops (000 ton) and estimates of residues ('000 ton)

Crops	2013-14	2014-15	2015-16	Average	Multiplier	By products	Estimated agro-waste
Wheat	11800	10354	11352	11169	1.5	**Straw**	16753
Rice	3998	4006	4145	4050	1.3	**Straw, husk & bran**	5265
Bajra	831	670	652	718	4.0	**Stalks**	2871
Sugarcane	7499	7169	6510	7059	0.1	**Leaves/trash, bagasse**	2127
Cotton	2302	2300	1350	1984	0.9	**Stalks, hull**	1786
R & M	880	706	805	797	2.0	**Stalks**	1594

Source DAC & FW [10], converted to agro-wastes using multipliers as used in [11]

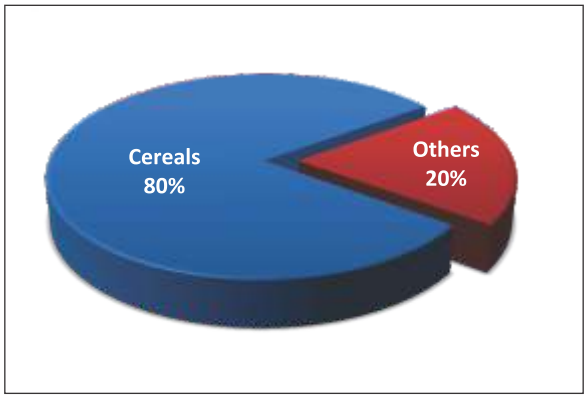


Fig. 22. Relative contribution of cereals to agro-wastes in Haryana

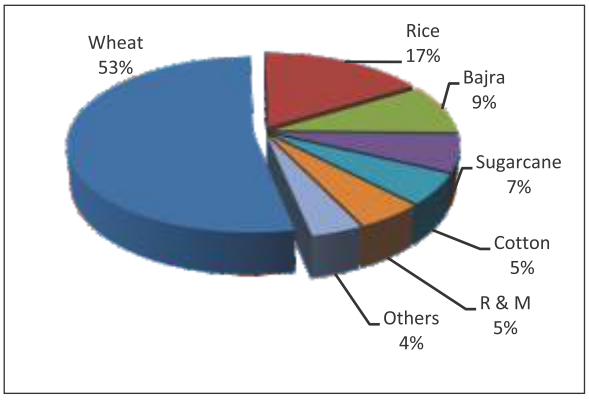


Fig. 23. Relative contribution of different crops in agrowastes in Haryana

Different mushrooms require different types of agro-wastes. Many of the mushrooms can be grown on wheat or paddy straw whereas some require saw dust. However, sawdust is not available in plenty in the state. China faced similar problem and alternates like cotton hulls and corn cobs were found to be suitable alternatives. Hence, agro-wastes from these crops can also be used for mushroom cultivation. Crop residues mainly comprise of cellulose, hemicellulose and lignin (Fig. 24).

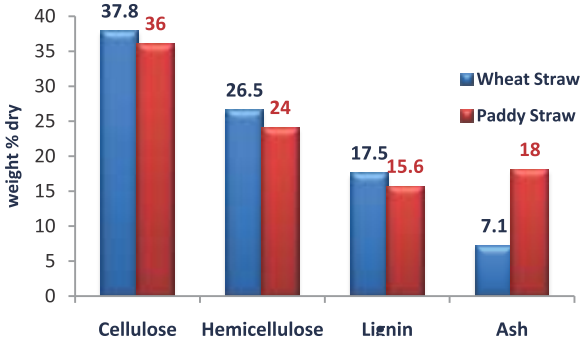


Fig.24. Meean values of different components in wheatand paddy straw [14]

Higher fungi including mushrooms are the prime category of organisms that can degrade lignin which is the second most abundant and the only aromatic biopolymer on earth. Burning of rice straw is a major problem causing pollution in the state and adjoining areas. Mushroom cultivation is one of the options to use this agro-waste and degrade lignin.

(b) Status of land holdings

Haryana has 1.34% (44,212 km^2) of India's land area. About half of the families have Less than two hectare land (Fig. 25) [12]. The Conventional agriculture cannot be remunerative on such small farms and there is need for diversification. Of the total 16.2 lakh operational holdings in Haryana, majority are small and marginal in size and only three per cent are really large holdings [13]. The average holding size in the state in 2010-11 was 2.25 ha. The average size of holdings has been steadily declining over the time. The small size of holdings limits the farmers' capacity to invest in advanced technologies and harvest higher yields through conventional agricultural approaches.

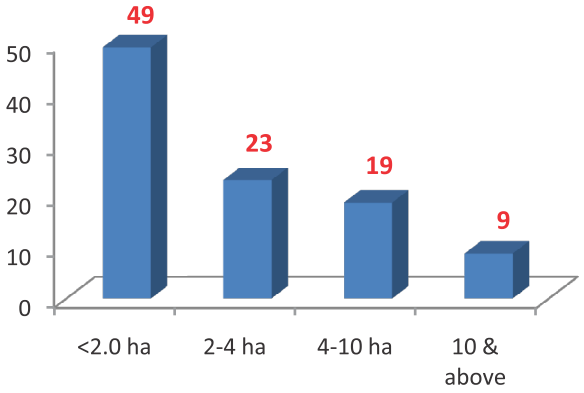


Fig. 25: Land holding pattern in Haryana [12]

The share of agriculture sector in state's economy has been declining over the years. The share of Agriculture and Allied Sector in GSDP has declined from 60.7 per cent in 1969-70 to 21.3 per cent in 2006-07 and further to 15.3 per cent in 2013-14 [13]. Allied sectors like dairying, poultry, fishery, arid horticulture, mushroom farming, bee keeping, agro-forestry have a considerable scope for the diversification of agricultural as well as off farm opportunities. The ideal location of state bordering National Capital Region (NCR) enables access to a range of big markets.

Considering the declining land holdings and reduced income from conventional agriculture, mushroom cultivation can be an ideal vocation, especially for educated youth, women and retired army personnels.

(c) Status of Manpower/ Population/ Education

In the four decades from 1971 to 2011, the population of the state increased by over 2.5 times from 100.37 to 253.53 lakh. The literacy percentage in this period also increased from 26.9% to 76.6%. (2011 census data) [7]. The increasing population requires quality food and educated youth requires employment avenues. 65% of the population is still in villages (Fig.26a) and about 90% of the villages have population less than 5000 persons (Fig. 26b). About 90% of

the population is below 60 years (Fig. 26c) and half of it is in the age bracket of 20-59 years (Fig. 26d) and major part of it is represented by educated youth and women. Hence, required manpower is available in the state.

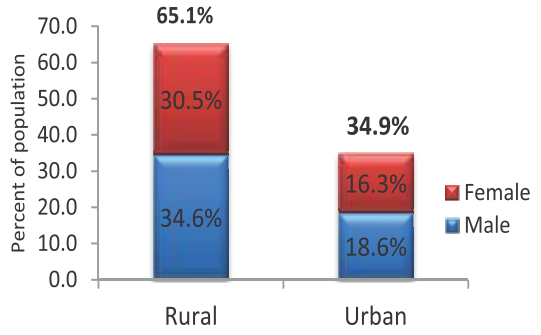


Fig. 26a). % population in rural & urban areas Census 2011 [7]

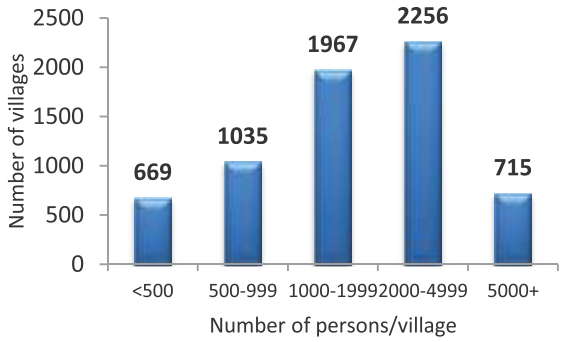


Fig 26b). Population wise distribution of villages [7]

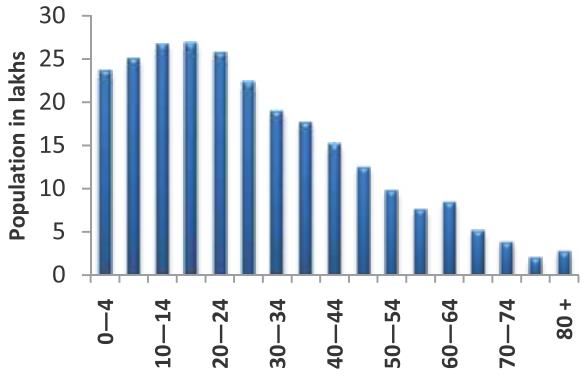


Fig 26c: Age-wise distribution of the population [7]

(d) Status of income from Agriculture

The rates of agricultural labour in the state are about Rs 400 per day (Fig.27) or about 1.5 lakh per annum. From the Table 9 it can be seen that earnings from conventional agriculture are very

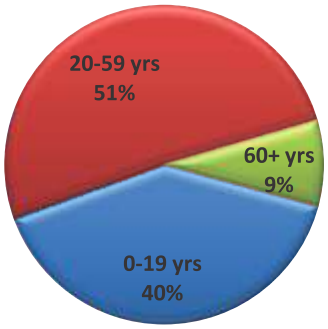


Fig 26 d: Relative share of different age groups in the state population [7]

less which means that a small farmer after doing all the labour in conventional agriculture may not be able to earn equivalent to simple wages of a labourer, especially ifthe cost of the land is also included in the cost of cultivation. It is in this context that the shift to ventures like mushroom cultivation becomes important.

Table 9: Average price of different crops in Rabi 2015-2016 and Kharif 2017

Crop	Average returns (Rs.)	
	without cost of land/ha	with cost* of land/ha
Wheat	52390	11998
Mustard	39018	13670
Paddy 1121	85515	33273
Paddy PR	73418	21968
Basmati CSR-30	94738	35750
Basmati Pusa 1509, PB-1	73148	23860
Bajra	12565	-6030
Maize	28445	750
Guar	14910	-3140
Cotton	40683	11725
Jowar	44880	12398
Arhar	51033	32035

*** Management charges, risk factor, transportation and rental value of land. Source: Dept of Agricultural Economics, CCSHAU, Hisar**

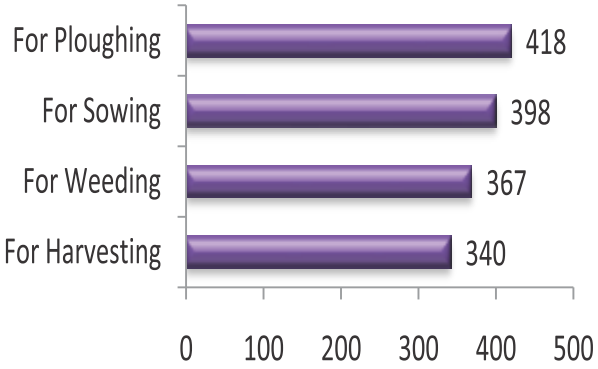


Fig. 27: Labour rates for different agricultural operations in 2017 [7]

(e) Quality of water available

Any water that is fit for human consumption is considered good for mushroom cultivation. There is a notion that mushrooms require lot of water. The fact is that production of one kg of rice may require up to 3000 litre of water, whereas production of one kg of mushroom requires only about 25 litre of water. Water of good quality is not available in some parts of the state, but considering that its requirement is very less for mushroom cultivation; mushrooms can be cultivated in almost all parts of the state.

(f) Gypsum and other raw materials

Gypsum is an important ingredient for making compost of button mushroom. It is used in the state to reclaim soils in some parts. Adequate amount of gypsum are available in the adjoining state of Rajasthan. Other inputs like bran, cakes and fertilizers are easily available in the state.

(g) Status of Electricity in the state

Energy is a critical factor in infrastructure for sustained economic growth. Hence, affordably priced reliable supply of electricity is necessary for effective development. The total installed capacity available to the State at present is 11262.30 MW and the balance is as share in central projects and Independent Private Power Projects [15]. The power availability from these sources during the year 2016-17 was 4,54,659 lakh KWH. Power sold during the year 2016-17 was 3,39,931.52 lakh KWH. The details of power available for sale and actual consumption of electric power in the state (Source: HVPN Ltd.) is shown in Fig. 28 .

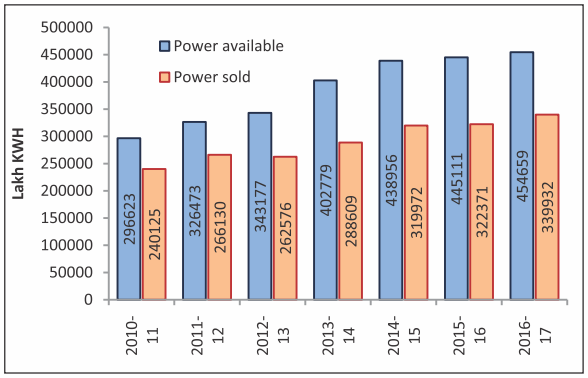


Fig. 28: Power available for sale and actual consumption of electric power in the state (Source: HVPN Ltd.)[15]

The relative share of agriculture in terms of electricity consumption was high in 90s and at present it is around 29% (Fig.29 a&b). Share of agriculture and industry is almost same at present.

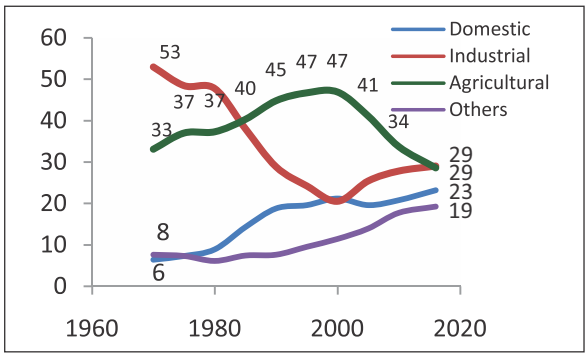


Fig. 29a: Share of different components in electricity consumption in Haryana (1970-2016)

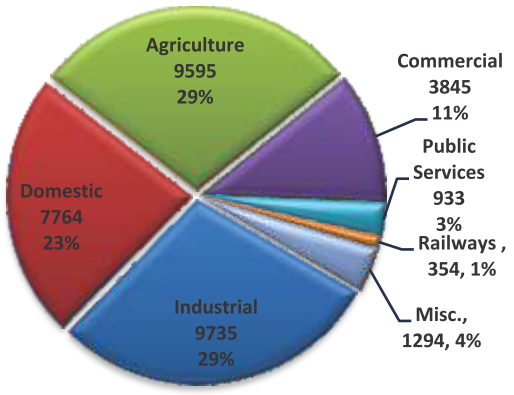


Fig. 29b: Sector-wise electricity consumption 2016-17 (MUs) [15]

Commercial mushroom units require assured and uninterrupted electricity. Electricity rates for mushroom cultivation are same as for industry and at times as reported by the farmers, there are unannounced breaks which add to the cost. The unit rates are high (>Rs 7/unit) as compared to adjoining states of Utrakhand (Rs 1.84/unit) and Delhi (Rs 1.50/unit) (Fig. 30).

To give boost to mushroom and other agro-vocations, it is important that we don't only ensure continuous electricity, but also provide the same at competitive rates.

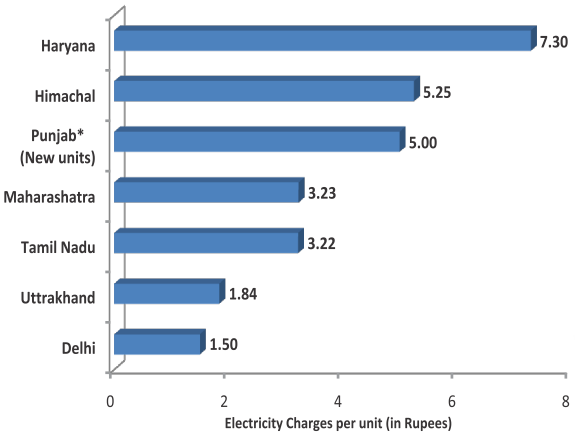


Fig. 30: Rates of electricity in Haryana and other states

Farmers of Haryana sell mushroom in Delhi and so do the farmers of Utrakhand and other adjoining states. In commercial cultivation, electricity adds to the cost significantly and hence it is important that electricity rates are rationalized.

(v) Status of inputs like spawn, compost, etc

Primary inputs required for cultivation of button or any other mushroom are the spawn and compost. The other steps in cultivation include cropping, processing and marketing (Fig 31).

(a) Status of spawn production

Spawn is the primary input and normally a major constraint. The technology for production of grain spawn is well known (Fig 32). For cultivation of wood fungi countries like Japan, China and Korea use liquid spawn, but this technology is not available in our country at present.

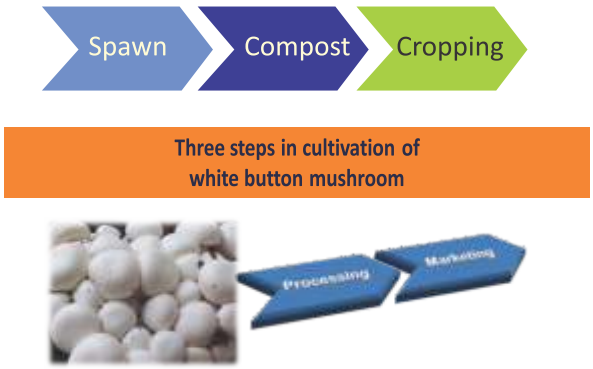


Fig. 31: Steps in mushroom cultivation

Spawn production involves par-boiling of the grains, their partial drying and mixing with Calcium carbonate and Calcium sulphate to adjust pH and avoid sticking. These grains are then filled in polypropylene bags which are autoclaved, inoculated with desired culture and incubated for few weeks for complete colonization of the mycelium (Fig. 32). Culture can be obtained from a standard lab or is made from fruit body, multi-spore culture or single spore culture. Such cultures need evaluation before being used for raising commercial crop. A standard spawn production unit will have grain boiling area, boiler room, mixing and bag filling room, cooling room, inoculation room,

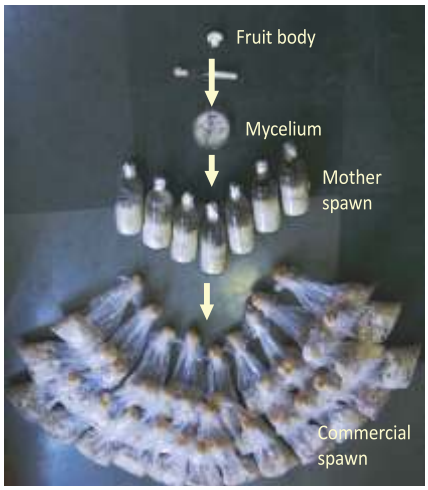


Fig. 32: Procedure for spawn production [16]

incubation room, cold room and machinery like autoclave, laminar flow, BOD, etc. There is lot of variation in these components in different spawn labs as there are no defined standards for spawn labs in the state. Only big growers tend to make their spawn in our country. In Haryana almost all the growers purchase readymade spawn. It may also not be economical to make your own spawn if the annual mushroom production of unit is 1000 Ton or less. Spawn is produced in the state in both government and private sector. In fact, Haryana has emerged as an important player in spawn production and meets the needs of the adjoining state as well.

Most of the private labs are secretive about the data. Effort was made to contact some of the major suppliers of spawn. Some of the spawn labs in the state are as shown in Table 10. Not all the spawn produced in the state is utilized within the state. On the other hand, many mushroom production units in the state procure spawn from Delhi, Utrakhand, Himachal or Punjab due to rates, quality or convenience. The rough estimates of the spawn produced, sold outside and procured from outside is shown in Fig. 33. According to these estimates about 1000 ton spawn is used in the state per year and about 150 ton of it is procured from other states.

Table 10: List of some of the spawn suppliers in and around the state

Name of spawn producer	District	Address of spawn producer/seller	Phone number	Spawn produced (MT/yr)	Sold in the state (MT)
Producers Within the State*					
Jai Bhagwan	Gurugram	Jai Bhagwan Spawn Lab	9416088983	225	170
HAIC Agro	Sonipat	HAIC Agro R&D Centre	0130-2484107	155	100
Navneet	Hisar	Poriya Spawn Lab	9896141214	150	100
Harpal Bajwa	Kur'shetra	Bajwa Mushroom Farm	9416037310	143	53
Deepak	Sonipat	Spawn India	9255299622	150	140
Sheeshpal	Panipat	Malik Spawn Lab	9050046301	70	60
Ashok	Sonipat	Sindhu Spawn Lab	9812012072	60	50
Sultan	Kur'shetra	CS Spawn Lab	9813711111	60	50
Arun Behal	Sonipat	Swadshi Spawn Lab	9953764791	60	60
Pardeep	Sonipat	Pardeep Spawn Lab	9896696677	50	38
Man Singh	Ambala	Madhav Fresh Food	9315122885	10	10
Charan Singh	Panipat	Charan Singh Spawn Lab	9416264137	10	10
Dinesh	Sonipat	Asha Spawn Lab	9991145663	4	4
Others**				5	5
Total				1152	850
Outside suppliers					
Naveen	Utrakhand	Welkin Foods	9719339977		53
	Solan**	DMR, Pearls, etc			55
	Delhi**	Misc/ import			42
Total					1000

* Based on feedback from the suppliers / stakeholders, ** Estimated

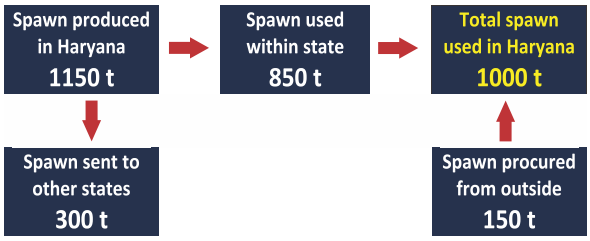


Fig. 33: Spawn production, sale and procurement from outside

Considering the total amount produced in public and private sector and utilized in the state, there seems to be gross mismatch in production of spawn and mushroom in the state. The spawn required to produce a specific amount of mushrooms depends on rate of spawning and biological efficiency. Accordingly, if the above values of spawn production of the state are taken then the spawn produced in the state is sufficient to produce more than double the amount of reported amount of about 11000 ton of mushrooms in the state in 2017-18. Expected Mushroom production = [(Spawn used/Rate of spawning) % x BE%]; = [(1000/0.7%)*21%] = 30,000 Ton.

One out of the four parameters (mushroom production, spawning rate, BE% or total spawn production) has to be wrong to account for these deviations. Presuming production figures to be correct, the BE may be only 14-16 % instead of 18-22 % and spawning rate may be 1.25 to 1.5% instead of 0.7% (Table 11). Under normal conditions of BE (18-22%) and spawning rate (0.7%), the total spawn required to produce 11000 ton mushroom should have been only 400-500 Ton.

Farmers may be using more spawn, Actual BE may be less or spawn data is exaggerated or production data inadequately collected. Actual value may be in between the reported and expected values. It appears that the actual production is higher than reported as it appears that data is being collected mainly from those growers that have taken benefit of subsidy. Many growers who avail no subsidy or those who have taken subsidy directly from NHB seem to have been ignored.

Table 11: Spawn required for producing 11000 ton mushroom at different rates of spawning & BE%

Rate of spawning	Spawn required (in tons) at Biological Efficiency					
	14%	16%	18%	20%	22%	24%
0.50	393	344	306	275	250	229
0.75	589	516	458	413	375	344
1.00	786	688	611	550	500	458
1.25	982	859	764	688	625	573
1.50	1179	1031	917	825	750	688

HAIC has been producing spawn in good quality as compared to any other government sector in the country. There has been continuous increase in spawn production. For example, Spawn production by HAIC Agro R&D Centre in 2000 was only 10 ton that increased to 45 ton by 2004. From 2004 to 2014 the average production was 48 ton. In the last three years there has been sharp increase in production and production in 2015 was 73 ton, in 2016 was 97 ton and in 2017-18 it reached 151 ton (Fig. 34). As already emphasized, all the spawn produced in the state is not consumed in the state. For example, HAIC in 2016-17 supplied 37% of spawn produced to the nearby states (Fig. 35). Major contribution in the spawn production was by button mushroom. For example in 2017-18, about 95 % of the spawn produced by HAIC was

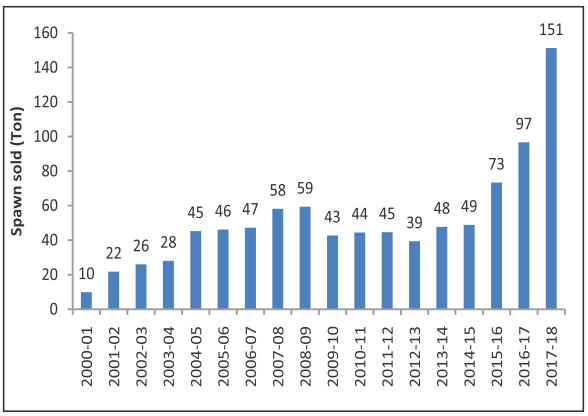


Fig. 34: Spawn production in HAIC, Murthal (2000-2018)

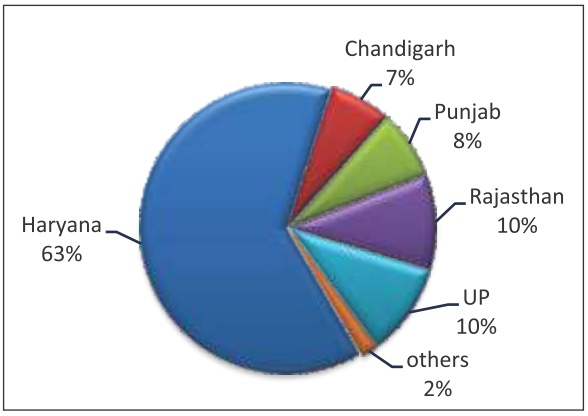


Fig. 35: State wise spawn sold by HAIC in 2016-17

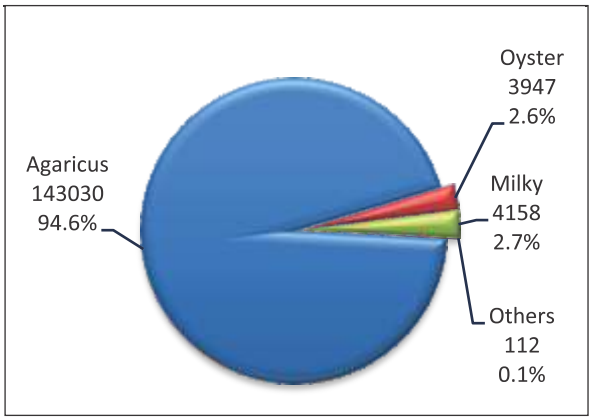


Fig. 36: Spawn production of different species at HAIC in 2017-18

that of button mushroom (Fig. 36). During winter season when the farmers start seasonal cultivation, there is sudden increase in demand (Fig. 37) and the spawn labs in the state are not able to meet the demand. As a result, farmers procure spawn from adjoining states. For example, the data obtained from Welkin Foods, Utrakhand, showed this trend (Fig. 38).

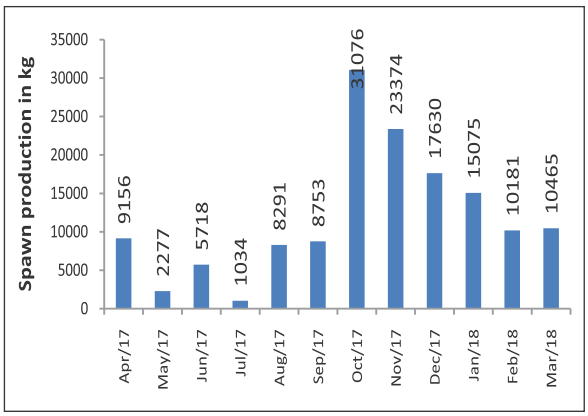


Fig. 37: Month-wise button spawn production at HAIC in 2017-18

Welkin Foods (Utrakhand) supplied 53.6 ton spawn to over 150 growers of Haryana in 2017-18 of which 15 growers accounted for over 50% of it. About 87% of the spawn was supplied only during October to December that is during seasonal cultivation. Some commercial growers obtain spawn from the nearby states throughout the year for reason of convenience or quality.

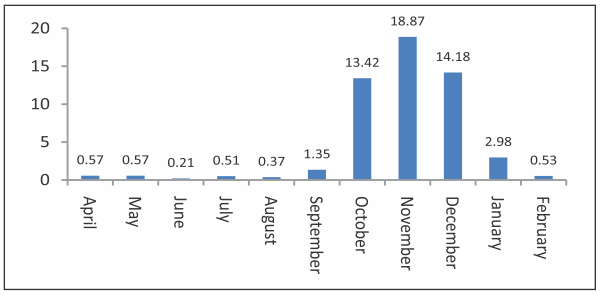


Fig. 38: Spawn supply by Welkin Foods, Utrakhand to growers of Haryana in different months

As discussed above, data was obtained from Welkin foods, Roorkee and we also interacted with some of the spawn suppliers in Delhi. The feedback from all the labs in the state and outside the state was that there is sudden increase in demand of spawn in winter. Despite all the efforts, all the labs in the state seem to be unable to meet the demand of seasonal growers. As a result, many seasonal growers obtain spawn from labs outside the state. However, labs inside and outside the state work at much lower capacity for rest of the year. For any spawn lab to be viable, it is important that there is continuous spawn production throughout the year.

How much spawn is used by seasonal growers?

The data on spawn used by seasonal growers vs. commercial growers was not available as such. The value of spawn used by seasonal growers was calculated indirectly by subtracting the average spawn used in the months when seasonal growers do not require spawn from the total spawn sold by major growers during the seasonal cultivation period (October to Dec). For this, month-wise data was collected from HAIC and three main private suppliers. It appears that seasonal growers consume slightly less than half of the spawn produced (~45%) and production of mushrooms based on short and long method is almost equal (Table 12).

Table 12: Estimated proportions of spawn used by seasonal growers as inferred from monthly sale by HAIC and three private suppliers

Particulars	Estimated Spawn used by seasonal growers	Estimated spawn used by commercial growers
HAIC Agro R&D Centre	59 ton	84 ton
Private supplier 1	100 ton	150 ton
Private supplier 2	42 ton	70 ton
Private supplier 3	65 ton	20 ton
Total	266 ton*	324 ton*
% share of spawn use	45 %	55 %
Spawning rate	1%	1%
Biological Efficiency	22%	18%
Expected mushroom production	5852 ton*	5832 ton*
Seasonal: Commercial production	50%	50%

* This is not the total spawn used or mushroom production in the state. The values have been calculated to estimate the proportion of seasonal vs. commercial production and do not reflect actual production

(b) Status of compost/casing production

Compost for button mushroom can be prepared by following long method of compositing (the oldest method that does not require many facilities and has now been discarded world over) or by short method (that requires bunkers and pasteurization tunnels). Both methods are followed in the state. Four type of cultivation systems were observed in the state based on cultivation as seasonal or commercial activity and method of compost preparation or procurement. These four methods are:

(i) Commercial units that produce compost by short method and grow mushrooms throughout the year. All commercial units produce their own compost. Such units contribute about 40-50% of the button mushroom. Mushroom by these growers is sold mostly fresh in punnets/poly-packs.

(ii) Seasonal growers who cultivate mushrooms from Nov to Feb on short method of compost and have set up tunnels to make their own compost. Such growers account for less than 5% of the production.

(iii) A few small scale seasonal growers in rural areas or those taking up mushroom growing as peri-urban horticulture activity purchase spawned compost made by short method. The contribution by these types of growers to mushroom production is miniscule.

(iv) Seasonal growers who cultivate mushrooms from Nov to Feb on compost made by long method. These farmers make their own compost and account for approximately half of the production of the state. Due to sudden spurt in mushroom production in winters there is decline in the prices as a result of which about 30% of

the mushroom production during this period is canned, though no exact data on this was available.

Compost by Long Method

It was observed that instead of chicken manure as source of nitrogen, these farmers use bran, various cakes and fertilizers. Farmers have standardized their own formulae and use it year after year. Few farmers also use chicken manure. Major problem is that whole of the activity is done outdoors, it takes a month to prepare the compost and the amount as well as quality of compost is of inferior quality. Only advantage is that farmers do not need to invest on developing infrastructure required for short method.

Major drawback is that despite the use of unwanted and almost banned chemicals, the disease incidence is higher in compost made by this method and every year number of farmers suffer from wet bubble and yellow mould. Farmers, however, have found a short term solution by shifting the cultivation to different site after every 2-3 years. Except the inputs like straw, bran, fertilisers, etc there is no specialized infrastructure or machinery required. Some of the seasonal growers who make compost on large scale do use tractors with front-end loaders or other machines to transfer and turn the compost/ compost ingredients.

Compost by Short Method

Short method of compositing requires infrastructure and machinery. Major advantage is the production of more and quality compost in short time (18 days or less), and no chemicals are used and instead the compost is pasteurized. It involves two steps. Phase-I (10-12 days) is done outdoors and involves mixing, wetting and turning of ingredients outside in the compost yard; and Phase-II (6-7 days) involves pasteurization and conditioning of compost as specific temperature and oxygen. Few year ago, phase I was done only by making piles, these days however most of the growers are using bunkers.

Compost production unit has under mentioned main components:

- **Pre wetting area:** For dumping of raw materials and their pre wetting (uncovered).
- **Composting yard:** For making piles out of the wetted materials (covered)
- **Phase-I bunker:** For phase -I composting (in case indoor composting is employed).
- **Phase-II tunnels:** For performing pasteurization and conditioning of the compost.
- **Casing soil chambers:** For pasteurization of the casing soil.
- **Spawning area:** For spawning of the prepared compost

The size of different components will vary with the proposed capacity of the unit. It is, however, important to synchronize various components. That is, after deciding on the design of the cropping room (described later) we calculate the amount of compost that will be accommodated in this room. Accordingly we decide the size of the tunnel so that compost required for that room can be produced in one tunnel. The size of bunker is determined by the size of tunnel and it is normally 1.25 to 1.5 times more in surface area than that of tunnel.

Similarly the size of yard, pre-wetting area will depend upon the amount of raw materials to be handled at any given point of time. In larger units mechanization for handling the raw materials and filling the compost in bunkers and tunnels may be a must. During visit to mushroom farms it was observed that many units lacked the synchronization among different components and only one unit was observed to have casing pasteurisation tunnel.

Central compositing facilities and total compost production in the state

Based on the production data and information on method of cultivation by the farmers of the state it can be roughly estimated that almost equal amount of compost is prepared every year by long method and short method. Considering the BE as 20%, the compost produced in the state will be five times of the mushroom production. In private sector most of the growers make their own compost. There are few government organizations like HAIC, Murthal that make compost by short method and sell it to the farmers. HAIC, Murthal in 2016-17 sold compost to the farmers as such or after spawning (Fig. 39) and about 90 % of the sale was within the state. HAIC has been supplying spawned compost to the farmers as per demand and the average compost sold during last 10 years was 405 ton (Fig.40).

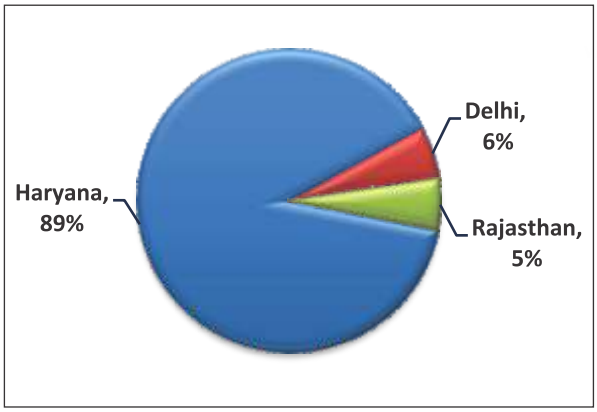


Fig. 39: Compost sale in HAIC Murthal 2016-17

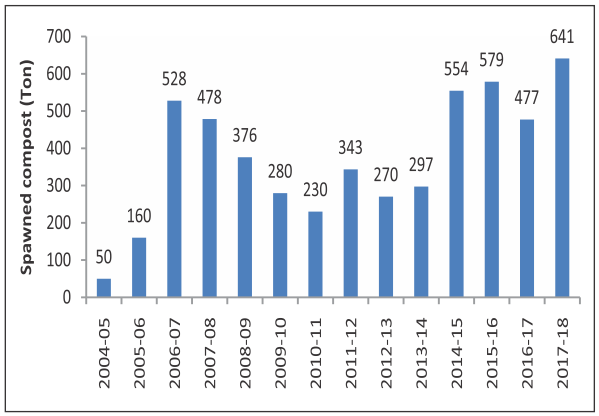


Fig. 40: Sale of spawned compost by HAIC, Murthal

Similarly, HAIC also provided treated casing to the growers as per need and has supplied on an average 37 ton of casing per year in last 10 years (Fig. 41)

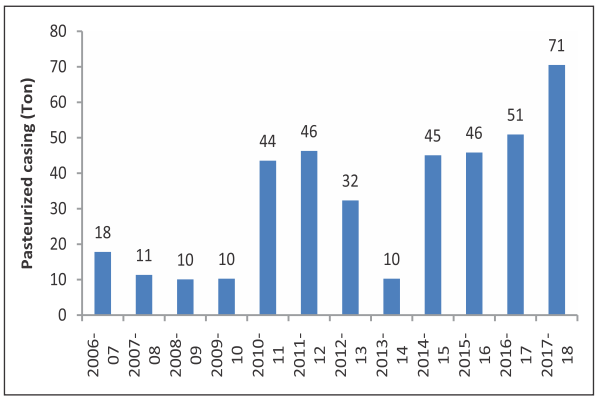


Fig. 41: Sale of pasteurized casing by HAIC, Murthal

(c) Status of crop production

General steps - spawning, casing, environment management

The general steps for cultivation are more or less same in both seasonal and commercial cultivation. After the compost is ready, it is mixed with spawn, filled on shelves or filled in bags. Seasonal growers fill the compost on shelves and do spawning there only. The compost is left as such at temperature of 23 to 25 °C for about two weeks for complete colonization of the compost by mycelium. Thereafter about 1 to 1.5 inch of specially made soil, called casing soil, is put on the spawn run compost and mycelium is allowed to penetrate the casing layer that may take about 10-15 days or so. At this stage temperature is kept at 23-25°C. Thereafter to induce fruiting, temperature is lowered to 16-18°C in 2-3 days and Carbon dioxide is lowered to 1000 to 1500 ppm by introducing fresh air. Only difference is that seasonal growers take advantage of the climate and commercial growers use electricity to achieve these parameters. Within few days mushroom start appearing and by repeating the same process of lowering temperature and giving fresh air, more flushes of mushrooms are

taken. Commercial units take only 2-3 flushes whereas seasonal growers keep on taking crop till mushroom keep on appearing (5-7 flushes).

Seasonal vs. commercial crop production

No precise data was available on the number of seasonal and commercial growers in the state. It is estimated that over 1000 persons are growing button mushroom as a seasonal activity and there are 10-15 major commercial units each producing more than 100 ton per annum (Annexure 4). Even though seasonal growers take only one crop, but their contribution to total production seems to be equal to that by the commercial growers. No production-system-wise data was available. The estimates are based on the estimated spawn sale to commercial growers and seasonal growers as discussed in status of spawn production.

Long-method vs. short-method-wise crop production

Most of the seasonal production is based on long method of composting. However, there are few growers in Hisar, Kurukshetra, etc that make their own compost by short method for seasonal cultivation and there are others who just purchase short method compost. Hence in broad terms the production by two methods may be more or less at par. In the last decade there are many commercial units that have come up and produce button mushroom throughout the year. With increase in labour costs, problems faced by seasonal growers most of which use long method compost and growing awareness about quality, the use of compost made by short method and production under controlled conditions is bound to increase and scenario after a decade may be totally reverse (Fig. 42).

Structures for crop production

Seasonal growers in Haryana grow button mushroom during, winter months from September to March. They cultivate this mushroom in the thatched structures employing long method of composting. Few growers make compost by short method for seasonal cultivation and a few purchase short method compost. This is convenient, productive and economical over long method compost and in addition to more yield in less time, the incidence of diseases is less. In general the farmers usually take single crop in the entire season and are harvesting 12-25 kg mushrooms/100 kg compost used.

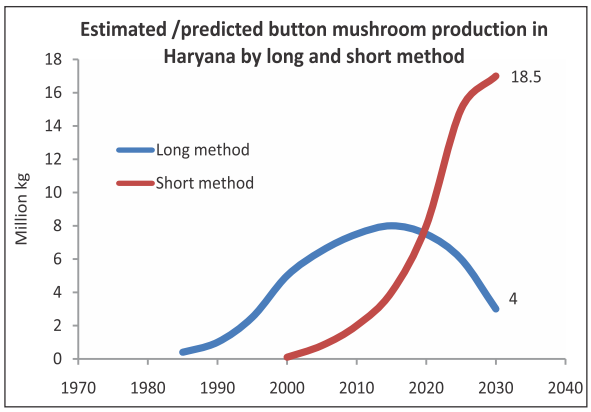


Fig. 42: Estimated button mushroom production in Haryana by long and short method.

[Total production in 2030 estimated as 22.5 million kg by Department of Horticulture, Haryana] (hortharyana.gov.in /en/statistical-data-0)

Farmers have standardized the design and method of construction of huts and use of plastic sheets both inside and outside to partly manage the temperature and aeration and avoid any damage due to rains (Fig. 43). Most of the farmers use huts of the size of about 28-30 feet x 60 feet or so (Fig. 43). It is so designed that it accommodates about 10-12 ton compost the starting material of which can be transported as a single truck load. The first step is to mark the lay out on the ground as per the plan followed by digging holes, inserting bamboos, making racks using plastic rope, covering the hut with paddy straw that has polythene inside in the roof part to avoid damage due to rain and also sheets outside the sides of hut to control aeration and temperature. The polythene sheet

is also spread on the racks and cultivation is done in beds instead of bags (Fig.43).

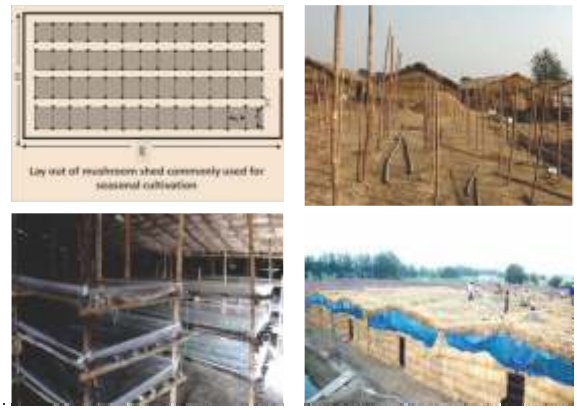


Fig.43: Lay out and different steps in the construction of hut

In commercial unit it is important to have 6-8 rooms for efficient use of tunnel and ensure regular mushroom production. The rooms can be on one side or on both sides of the corridor. All rooms are insulated using thermocol or are made of 60-80 mm thick PUF panels. It is important to understand that width of room and height of room cannot be arbitrary. Width of room will depend upon the number of rows of racks that are proposed to be put. Normally the width of rack is around 4.5 feet. The width of path in between racks is never less than 3 feet and preferably may be one meter (3.3'). Thus, if there are two rows, there will be three paths and thus width of room will be = 3.3+4.5+3.3+4.5+3.3 = 19 feet. These are inside dimensions and we can add values for walls and insulation. However, at most of the units we visited, it was observed that it was not followed. To accommodate more compost farmers were sometimes keeping less distance between the racks or making half racks (2 to 2.5' wide) on the sides of walls. All this lead to improper air circulation and difficulties in harvesting and cleaning. Net result was less yield.

Similarly height is determined by number of shelves in a rack. There is fixed space below the lower most shelf and also above the top most shelf. Distance between shelves is 2'. For four shelves a room of 10.5 height is required, for five shelves 12.5'; for six shelves, 14.5' and so on. Two feet are added to height for every shelf (Fig. 44). It was observed that some of the growers tended to compromise here too so as to increase the number of shelves. Less distance between the shelves leads to problems in air circulation, watering and harvesting. Length is normally three times the width of the room. It can be somewhat more or less but air circulation becomes somewhat difficult if length is more than 100 feet.

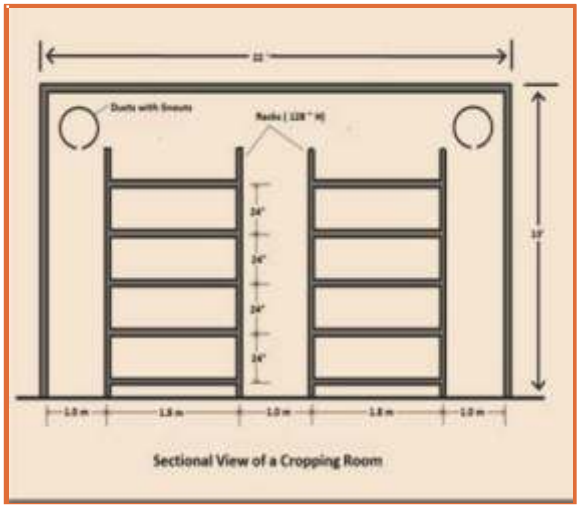


Fig. 44: Design of cropping room with two rows (Front view)

In the above design of room, there are supposed to be two air ducts on the sides with holes on lower side. Fig. 44 shows cross section of a cropping room. The size of the duct, size of hole and distance between holes will depend upon the fan in AHU, dimensions of the room. These ducts are connected to Air Handling Unit (AHU) which has mechanism for cooling, fresh air and also humidification. The amount of the air and cooling capacity of AHU is determined by the maximum amount of compost proposed to be filled in the room. Here too, it was observed that no proper calculations are done to calculate the size of air circulation pipe, dia and number of holes per pipe, etc. The AHU has to have a provision for fresh air and in most of the cases fine filters were lacking. Hygiene is the key to

mushroom production and farmers were not following the right practices or were not fully aware of these practices due to lack of publication of Good Management Practices.

In developing countries growers follow a standard design of mushroom cropping rooms that helped in mechanisation of the systems like filling, casing, emptying and harvesting of the mushrooms. It is important that similar designs may be developed for our country so that mechanisation of different steps becomes easy. Similarly, they also cookout the compost after completion of the cropping cycle. This practice is lacking at all the units in the state.

(d) Farmers Innovations

In the beginning in 80s farmers were making compost by long method. Diseases were bound to get established when we use this method of cultivation and don't give adequate emphasis on hygiene. Farmers found an alternative to the problem and they won't grow mushroom at one location for more than two or three years. Farmers use formulae with bran or cakes and fertilizers as N source instead of chicken manure which is the main source of yellow mould and other diseases. However, this may not a long term solution and best way may be to shift to short method of compositing.

Another innovation is in the method of turning where farmers make large number of piles in parallel and to turn, take one half of the two adjacent piles to create a new pile. Half left at the end in last pile is turned over itself as a result of which we may see a shorter pile at one end (Fig. 45). This ensures that the inside of the pile comes to the outside after each turning and there is adequate aeration. Farmers have also standardized the height and it is only kept 4-5 feet as the outside climate when compost is made is relatively hot and aeration may be less if pile height or width is more. In the beginning farmers use wheat straw but later on shift to paddy straw as the same is much cheaper costing less than half of the cost of wheat straw.

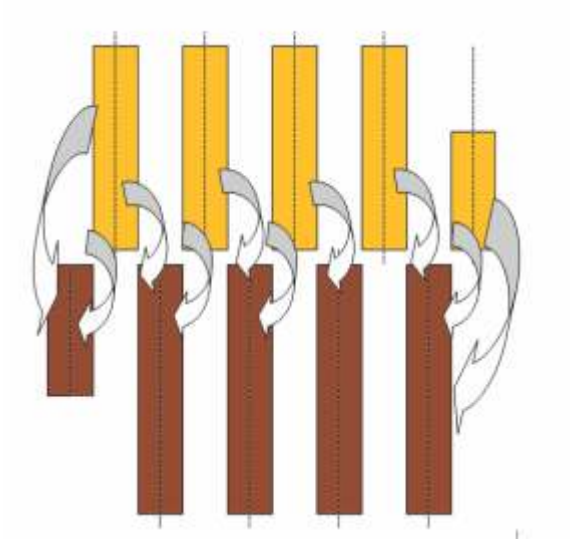


Fig. 45: Compost piles and method of turning

(vi) Status of Policy and Technical Support

MIDH and department of horticulture have been promoting mushrooms through various schemes in the state. Technical support has been provided by HAIC Agro R&D Centre and CCS HAU Hisar.

(a) Mission for Integrated Development of Horticulture (MIDH)

Assistance provided by MIDH for setting up of individual mushroom production, spawn production and compost making units, is as per the details given below [24]:

i) Production unit (cost Rs 20 lakh /unit): 100% of the cost to public sector and 40% of cost for private sector, for meeting the expenditure on infrastructure, as credit linked back ended subsidy.

ii) Spawn making unit (cost Rs. 15 lakh/unit) 100% of the cost to public sector and 40% of cost for private sector, for meeting the expenditure on infrastructure, as credit linked back ended subsidy.

iii) Compost making unit (cost Rs. 20.00 lakh/unit) 100% of the cost to public sector and 40% of cost for private sector, for meeting the expenditure on infrastructure, as credit linked back ended subsidy.

Thus total subsidy on all the components at present is Rs 22 lakh. Many farmers have been taking advantage of the scheme but there was sudden increase in number of beneficiaries from 2015 onwards (Fig 46).

In the last decade MIDH (NHM) has given subsidy to 95 units for various components of mushrooms and in last five years five units have availed subsidy from NHB (Annexure 5), and considering these the number of commercial units should be much larger as all of these are related to button mushroom.

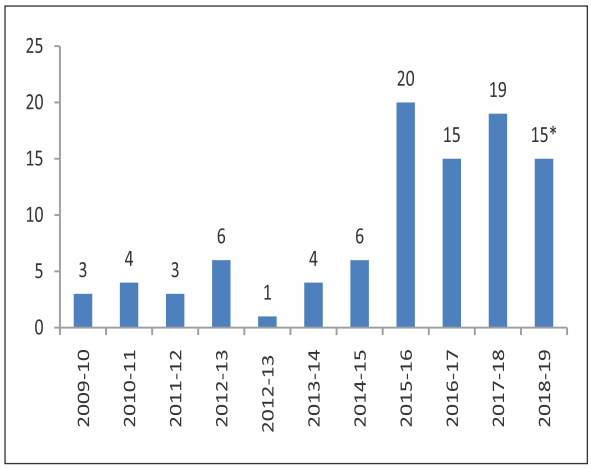


Fig. 46: Mushroom units funded by SHM/MIDH in different years (2009-July 2018)

The number of beneficiaries in the last decade has been more in districts like Karnal, Kurukshetra, Panchkula, Jind and Yamunanagar (Fig 47). The list of beneficiaries is enclosed as annexure 5. There is need for feedback analysis as the interaction with some growers indicated that many of these units could not progress.

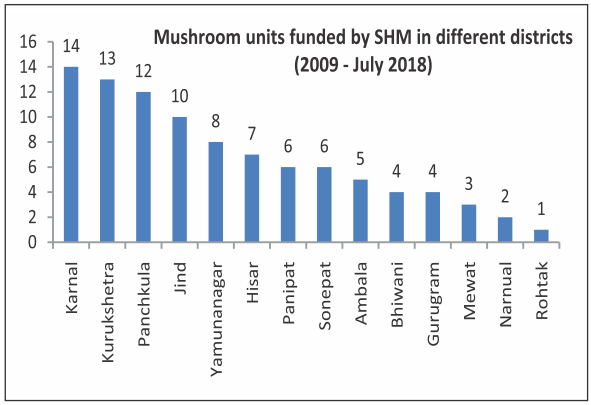


Fig. 47: Mushroom units funded by SHM/MIDH in different districts (2009-July 2018)

The committee is of the view that the funding is inadequate and not sufficient to set up a viable unit. The limit may be raised to at least 75 lakh and there should be flexibility in use of this fund to set up a spawn lab or compost unit or cropping room or any of the two or all three subcomponents instead of integrated unit. It is not possible to set up a spawn lab in 15 lakh as a good autoclave alone may cost more than this. Similarly, for round the year cropping, at least six cropping rooms are required and with the present limit of 20 lakh it is not possible to make even two good cropping rooms, each with a capacity of 20 ton. However, the subsidy under mushroom scheme may be given only once.

Under MIDH schemes, the state share in NHM funded schemes has increased over time from 15% to 40% and good amount of funds of plan scheme are utilized to meet this demand. Our interactions with the mission director indicated that there is adequate support from the state and unlike many other states adequate provision is made.

(b) State Plan Schemes for Integrated Horticulture Development (IHD)

- ***IHD Plan Scheme for Non-NHM Districts (Kaithal, Rewari and Faridabad)***

Mushrooms cultivation demands heavy investment in the initial stages. It was observed the state has been proactive in providing subsidy to all sections of the society. The current scheme under MIDH/NHM having a provision of 40% subsidy on cost of Rs 55 lakh for mushroom unit as mentioned above is not applicable in the districts Kaithal, Faridabad and Rewari. The state plan covers these districts with same terms and conditions. However, the response for mushroom cultivation in these districts seems to be less as in Annual Action Plan of Department of Horticulture for 2018-19 there was provision for only one compost unit (20 lakh; subsidy 8.00 lakhs) [17].

- ***IHD Plan Scheme for promotion of horticulture in Shivalik area***

The IHD plan scheme also covers Horticulture in Shivalik area (Panchkula, Ambala, Yamnanagar) and provided 75% assistance for mushroom sheds with unit cost of Rs 50,000 (Subsidy per shed = Rs 37500). In 2017-18, 51 sheds against the target of 44 were made in this area. From each shed grower produces at least 2 ton mushroom implying that there was over 100 ton mushroom production under this sub-component. For 2018-19 there is 75% subsidy on tray costing Rs.300/- with maximum limit of 100 trays per beneficiary. Target for 2018-19 is about 5000 trays for Panchkula, 8000 trays for Ambala and 10000 trays for Yamunanagar [17]

- ***IHD Plan Scheme for SC families (SCSP)***

In the Integrated Horticulture Development (IHD) Plan Scheme for SC families (SCSP) there is provision of mushroom trays with maximum subsidy @ 90% of total cost of Rs 300, i.e., Rs 270 per tray limited to 100 trays/beneficiary. In terms of bags it means about 300 bags of 10 kg each. In 2017-18 the targets (68398 trays, details in Annexure 5) were met fully and 2052 ton compost was supplied which means production of over 400 ton of mushroom.

The production expected by each family from 100 trays is about 600 kg which at the rate of Rs 70/kg means Rs. 42000. In 2-3 months the family is able to earn about Rs. 39,000 as additional income. The subsidy and the number of trays seem to be appropriate. The target for 2018-19 has been fixed as 51134 trays (=1534 tonnes) with 2000 or more trays in most of the districts [17].

- ***Rashtriya Krishi Vikas Yojna (RKVY)***

There was provision of 50% subsidy on mushroom trays under RKVY in all districts with maximum of 100 trays per beneficiary. However, the rate of one tray here was taken as 220 instead of Rs 300 as was in Sub Plan for SC. In 2017-18 over 1400 ton compost was provided in all the districts that means an additional production of about 300 ton of mushroom. In annual action plan 2018-19, there is provision of Rs 24 lakh under RKVY for 12 districts for promotion of vertical cultivation technologies. Mushroom farming is a good example of vertical farming.

On the whole, allocation of budget is adequate. There can be separate provision of funds for ex-service men on the lines of SCSP scheme as ex servicemen constitute an important segment in the villages, and because of the discipline inculcated in them, they have the potential to promote mushrooms. The scheme can also be extended to other mushrooms instead of focusing only on button mushroom. The overall share of mushroom in total horticulture budget

is small. However, benefits of increasing allocation to mushrooms may be much higher than other horticultural activities as mushroom are the highest protein producers per unit land per unit time and provide highest amount of income from limited area.

As far as we know, there is no pre-requisite on use of short method compost in different IHD or RKVY schemes listed above. It is important that in the interest of growers, this rider is included in the terms and conditions of these schemes. To give impetus to these schemes it is important that only short method compost of best quality is provided. Unfortunately, the state lacks compost production hubs in each district and commercial growers normally do not sell compost.

Some of the changes proposed are:

- Change from tray to bag of 10 kg for subsidy and data collection.
- Include Ex-service men for 90% subsidy in existing schemes and the targets may be revised accordingly (may be doubled) by making separate provision for them.
- Subsidy may be given on sheds and partial subsidy may be given for sheds for 2nd and 3rd year too to the same beneficiary for compost. This will ensure that mushroom cultivation is not a onetime affair.
- Subsidy for trays may be restricted to only short method of compost
- Need to provide similar subsidy for oyster and milky mushroom or RTF bags of any mushroom.

This will:

1. Promote mushroom cultivation in Haryana.
2. Generate employment among rural youth.
3. Reduce nutritional gap.
4. Enhance the profit of the growers.
5. Recycle the agro-wastes like wheat and paddy straw to produce wealth from waste.
6. Promote organic farming through use of spent mushroom compost

ToR - II. Problems of Mushroom Growers & other Stakeholders

The problems of various growers are linked to availability of spawn and compost. In India only few units make their own spawn. Most of the commercial growers and all the seasonal growers depend on the supply of spawn from government or private suppliers. Regarding compost, most of the farmers make their own compost and only few purchase it. However, most of the seasonal growers make compost by long method while commercial growers make compost using short method. Various problems related to spawn, compost and cropping are discussed here.

(i) Problems related to spawn production and availability

There was very little awareness about the varieties and different cultural conditions required for cultivation of each of these varieties. At present we do not have any laws for mushroom spawn (=seed) as a result of which many spawn suppliers are providing spawn from unknown sources and multiply it generation after generation beyond the permissible limits. There is unauthorized import and each private lab gives its own name to the variety that adds to the confusion.

There is no seed certification for mushroom cultures or spawn. Many suppliers do not even put any tag showing date of spawning, name of strain, batch number, etc. as it is not mandatory; hence, no protection to the farmers. Unlike crops, there is no variety release procedure. In fact no variety of mushrooms has been released by any agency of Haryana. There is also no registration of labs. A profrma has been developed for the registration of the labs (Annexure 6).

There is lack of big labs to produce quality spawn on large scale. Only lab method is used for large scale spawn production in bottles or polypropylene bags having neck ring and cotton plug, whereas companies outside India like Sylvan have fully automated spawn production in breathing bags where inocculation and bag filling under sterile conditions is fully automated instead of lab method of inoculating each bag manually. It is important that we may focus on establishing state of the art facilities for meeting the increasing demands of future.

There is lack of transport systems for spawn or their storage at different distribution points in the state. It may be apt to have central spawn production lab with distribution centres in different hubs having all facilities for medium term storage of spawn.

Some of the problems are due to lack of awareness about the precautions to be taken while purchasing, transporting and storing spawn. Many a times contaminated, unripe (not fully colonized) spawn is provided to the growers. Sometimes spawn is transported in hot dusty environment and is not stored in cool and dry place by the growers which results in contaminations.

(ii) Problems related to compost/casing

There is lack of testing facilities of ingredients, and formulations used by the growers are based only on experience. Lack of facilities for testing ammonia, Carbon dioxide, oxygen while composting, especially by seasonal growers forces the growers to depend only on experience and failures due to error at one or the other stage frequently occur. Most of the seasonal growers make compost by long method which is invitation to diseases.

Short method - Phase I: Hardly any bunker was as per specifications as simple pipes are put in the floor that cannot bear the load of machinery. There is lot of variation at different units. No research seems to have been done on the type of fan or height of compost filling in bunker for the type of materials used by the growers of the state. Hardly any farm had the facilities for testing compost parameters. Majority of the farmers used high pressure system involving pipes for bunkers in Phase-I and low pressure system having plenum below the floor in Phase-II.

For Phase II, there are no standard designs for tunnel or parameters like slope, specifications of centrifugal fan in terms of air flow and air pressure, number and size of holes in the plenum, etc. with respect to our composts. It may be noted that materials and type of straws used in India are drastically different from those used in Europe or USA where uncut straw is used. No research has been done so far on type and degree of insulation for our conditions, air flow (CMH) and air pressure (cmWG) of fans required for our composts which have higher bulk density and resistance (as our straw are too short and also some growers use different types of materials like paddy straw, mustard stalks, soybean straw, sugarcane bagasse, etc). Specifications for different materials may be different.Installation of Variable Frequency Drive (VFD) may help in regulating fan speed as per need. No VFD was observed at any site in the state which is important to regulate air flow and also spend only required energy.

No computerization for controlling parameters like temperature, ammonia, oxygen, etc., which are highly important in Phase II, has been done at any of the commercial units in the state. Any small mistake will mean crop failure. Many farmers prefer to note hourly temperatures in duct instead of inserting thermometers in the middle, above and below the compost. Regular calibration of thermometers and cleaning of filters is a must. Farmers tend to ignore it and majorities do not even install filters at inlet of

fresh air in tunnel. Simple systems for partial automation developed at DMR, Solan are available where required maximum and minimum temperature can be set and there will be alarm as and when there is deviation and the grower can manually make the changes. Even such simple systems have not been adopted.

As a first step detailed analysis of different tunnels for their fan capacity, hole size, slope and other parameters is required and it can be linked to the production data or problems being faced in compost by these growers. Phase -II tunnels have plenum with slope having grated floor (Fig. 48). Tunnel can also be made using pipes fitted with spigots (Fig. 48).

Fig. 48: Tunnel with iron grating (above) and with pipes & spigots (below) (under construction)

When there is plenum then the floor can be in the form of gratings/strips or holes in the floor that are of 1-2" diameter. While using strips as shown in the Figure, it is possible to leave 20-25% free space by using 3 to 4" wide strips with 1" distance in-between. However, when holes are made in the floor, then it is difficult to achieve these values of free space and it varies from 5-10% or even less (Fig 49).

For example if we use holes of one inch dia, then to achieve different levels of free area, distance between holes will be as given in Table 13. This parameter has been changed at many units without any corresponding change in other parameters like speed & air pressure of fan, slope of plenum, etc.

Table 13: Free area in tunnel at different distance between holes of 1" diameter

% free area	No of 1" dia holes/sqm	Horizontal and vertical Distance (centre of one hole to centre of other)
1	20	8.8"
2	41	6.2"
3	61	5.0"
4	81	4.4"
5	102	3.9"
6	122	3.6"
7	143	3.3"
8	163	3.1"
9	183	2.9"
10	204	2.8"

Fig. 49: Holes in Plenum

It was observed that in majority of the tunnels in the state farmers were using holes with centre to centre distance of 6 inches. In one of the farms surveyed, the pipes were at a distance of 10" and the free space in the plenum was only 0.75%.

It may be apt that for high pressure system in bunkers, pipe to pipe distance may be about 40 cm, hole to hole 40 cm, hole dia 6 mm and fan capacity 30 cubic meter per hour (CMH)/m^2 with air pressure of 40-60 cmWG. For pasteurisation tunnel with pipes instead of plenum, the pipe to pipe distance may be about 30 cm, hole to hole distance 20 cm, hole dia 10-12 mm, fan capacity 160-200 CMH/m^2 with air pressure of 30-45 cmWG. Understanding of fan laws and fan curve is also important for making right selection of fan and motor. It is always better to consult experts/research organisations for exact specifications.

In Netherlands no mushroom grower makes compost and instead the compost for button mushroom is made by few companies like CNC, Hooymans, etc. These companies supply spawn run compost in their trucks or make spawn run compost blocks along with casing soil and supply to other countries as well. Spawn run is done in specially constructed tunnels and this phase is commonly referred as Phase III. This system is yet to be introduced in our country. There is need for promoting entrepreneurs to come forward to set up such facility. These ready to fruit blocks circumvent the difficult steps of making compost, spawning, spawn run (Phase I to Phase III) in mushroom cultivation and thus make the cultivation much easier. Similar approach is being followed for other specialty mushrooms where various companies are developing ready to fruit bags for other mushrooms as well. Pasteurized/sterilised substrates for *Pleurotus*, Shiitake and other lignicolous mushrooms is made by different companies in Europe, some of which are:

1. Lentin de la Buche (France}
   lentindelabuche.henry@wanadoo.fr
2. Eurosubstrat (France}
   www.eurosubstrat.com
3. Pilzzucht Hesse (Germany}
   pilzzuchthesse@aol.com
4. CNC Exotic Mushrooms (The Netherlands)
   www.cnc.nl exoticmushrooms@cnc.nl
5. Substraatbedrijf Horst (The Netherlands)
   www.substraatbedrijfhorst.nl

Support from the government in our country may help in establishment of such facility and satellite growers can develop around such nuclei.

The machinery in use in these countries is robust and designed to handle large volumes. However, for our state, it may be desirable to downscale the size of various machines. Hence, such machines may be imported, studied and modified to suit our conditions.

It was observed that at most of the units precautions at the time of spawning like sterilization of the area, protection from flies while spawning, rejection of contaminated spawn bags as such, etc are not followed. Except one farm, where there was complete protection, and spawning area was under positive pressure, the spawning by most of the growers is done in open which is an invitation to diseases and flies for egg laying. As a result many of the farms face problem of flies. Growers tend to use chemicals indiscreetly which is also one of the reason for low yield and some of the abnormalities observed at mushroom farms.

(iii) Problems related to cropping

The biological efficiency (BE) in our system is around 18% as compared to 32-35% in many other countries (Europe, America, Australia). Some of the reasons for this are:

At almost all the units there was improper design of rooms as a result of which there was no homogeneity in the temperature humidity and carbon dioxide. There was lack of understanding of air bed ratio, importance of air circulation, proper specifications of AHU, fresh air intake, Hepa filters, VFD, etc. Even the holes (number, size, direction) in air circulation pipes were made without any calculations. In the absence of proper guidance from the government institutions, most of the units are copying from other units and hence propagating poor technology. There is need for standard pilot scale plants in the govt system which can be replicated by the growers.

There was no automation in rooms for control of humidity, Carbon dioxide and temperature, as a result of which variations in these result is less yield and poor quality of mushrooms. Cropping as a seasonal activity is done in huts. On one side the growers are fully dependent on the vagaries of weather and on the other hand there is no insurance of huts made of straw alone and hence highly prone to fire.

At commercial units electricity supply and electricity charges remain a debatable issue. It is important that for success of this venture assured continuous electricity at reasonable rates may be provided to the growers.

(iv) Problems related to disease control

The seasonal growers make compost by long method and there are no facilities for hygiene or control of flies as a result of which diseases like wet bubble, yellow mould and flies are very common. Scenario at commercial units was not much different and diseases like wet bubble, bacterial blotch, damage due to flies was commonly observed. One of the reasons is that in our country we do not have any provision for cook out and little care is taken at the time of spawning. Due to variation in design and methods of cultivation, it becomes difficult to develop Good Management Practices. Even our methods of compost preparation are always not correct as a result of which indicator molds like brown plaster mould, inky caps, etc. are many a times seen. Proper farm design is the first step to hygiene. There is need to promote standard designs and develop GMPs for these.

Hygiene is the most important part of successful mushroom cultivation. In West, in addition to strict hygiene, they cook out the compost (70 °C for 8 hours) at the end of cropping. In our conditions there is lack of hygiene and no cook out is done. There were hardly any units using Hepa based filtered air at inlets in Air Handling Unit. Many growers don't use proper size mesh or filter at air outlets in the room which becomes as one of the reason of fly incidence. Farmers tend to control diseases using chemicals without realizing that indiscriminate use of these chemicals affects the yield. To add to the problems, casing is treated with chemicals instead of steam pasteurisation.

Our observations during visits

There are adequate suppliers for inputs and machines for spawn. For compost and cropping, however, the machines have been designed by copying from outside and need standardization. One of the possible reason is that there is no standard design for tunnels or cropping rooms and each machine is tailor made. It is important that machinery is imported and modified as per local needs by central/state govt. organizations.

Most of the commercial units have faulty design of cropping rooms with 2.5 feet racks on the side of walls. This helps in putting more compost in the room. But this creates difficulties in cleaning, disturbs air bed ratio and means more stress on air circulation.

There are no standard designs. Width of stands is not uniform nor the standard for the paths. This will make mechanization difficult. Even the number of tiers varies from 4 to 8. However, when the height increases, the air flow pattern changes. But there was no awareness about air speed required in different heights.

Many farmers were not even aware of the air flow and static pressure specifications of fan to be used in tunnel and considered the horse power of the motor or speed of fan as a measure. It is important that farmers are educated on having cone type holes instead of straight pipes in plenum floor because the former do not get clogged by the compost. Raw materials used in West are different as a result of which the bulk density of compost and its resistance is different. The specifications of the fan is a function of the resistance which will depend upon ingredients, depth of filling, moisture content of the compost filled in tunnel, number and size of holes, etc. However, no research work in this direction has been done for our conditions and we are using the standards developed for West.

In West peat is used as casing soil and is not pasteurized. In our country after experimenting with number of casing materials farmers have started using coir pith as the major ingredient. We face the problem of dry and wet bubble, blotch, etc and for this it is important to pasteurize the casing.

It was seen that most of the units were not having this facility nor the specifications for steam required to pasteurize a given amount of casing were available with scientific organizations. Almost all were using formalin to treat the casing. It may be added that during winter at temperatures below 20 °C, the vaporization and thus effectiveness of formalin decreases. Some growers add other chemicals which affect the growth in casing and sometimes cause abnormalities in the fruiting bodies.

No theoretical exercise seems to have been done on R values (measure of insulation) required for tunnel or cropping rooms for our conditions. Climate here is totally different and we need better studies on development of standard designs so that we can target 32% BE in place of 16-18% being obtained by most of our growers.

Automation for control of temperature, humidity, Carbon dioxide is important for better crops. But most of our growers don't have the facilities even to measure these except that of the thermometers which also are not always accurate and need to be calibrated. Awareness about hygiene is one of the most important non visible factors affecting yields in our country. There is dire need to make standard bunkers, tunnels, cropping rooms and their drawings and make these available to growers.

ToR - III. Status of Mushroom Processing Industry

(i) Processing

Button mushroom, like many other mushrooms, has a short shelf life. It may be consumed fresh, canned or pickled. There are number of canning units in NCR which procure the mushrooms particularly in winter when rates are low. Exact data on the amount of mushroom sent for canning, or how and where it is consumed, is not available (Fig. 50). From the Table 14 it can be inferred that about 2 lakh boxes (24 cans x 800 MB) are produced each year which roughly means that about 3000 ton of fresh mushrooms are canned. It can be inferred that about 30% of the production of the state is canned. As prices in winters are low, it is the apt time to can mushrooms. It appears that major share of the mushrooms that are canned is of those produced by seasonal growers. Many growers enter into contract of fixed price and it suits them that even though prices agreed to are low (Rs.60-65/kg or so), but there is stability in price, saving of labour and cost on punnets, film, polybags, etc. Fresh mushrooms are sold in punnets and small quantity is still sold in poybags.

The expenditure on production of one can is about Rs 65 (Table 15). The average selling price per can ranges from Rs.67 to 75 (i.e. Rs.1600-1800 per carton of 24 cans). Hence, canning may not be economical if the purchase price of mushroom is above Rs 67. Most of the canning is done in winters when prices are in the range of Rs 60-65. B grade mushrooms may be available at Rs 20/kg or less. Hence, sliced mushroom using this material will cost only Rs 36/can and the canned sliced mushrooms may be sold even at Rs 900 per carton of 24 cans. Loss in weight on blanching and grading is normally taken as 35% and it may range from 33% to 37% depending upon quality of mushroom. Costing per can may vary by a rupee or so with difference in loss in weight after blanching (Table 16).

Table 14: Some of the canners in and around the state and estimated canning capacity

Name and address of some of the canner in and around the state	Phone	Estimated canning capacity Ton/day*	Estimate of boxes (24 cans/box) canned/year*
Integrated Mushroom Unit, Rai, Sonipat	9416320765	4-5	5000
Partibha Foods, Aterna, Sonipat	9416402766	4-5	5000
Shell Mount, Aterna, Sonipat	8816938901	4-5	5000
Naresh Khatri, Bahalgarh, Sonipat	9999500415	5-10	5000
Tasty Foods Rai, Sonipat / Delhi	9811426077	15-20	20,000
Golden Crown, Narela, Delhi/ Ghaziabad	9810480331	25-30	50,000
Kaytis/ Vidyasagar foods (P) Ltd Kundli/ Delhi	9810138373	20-30	35,000
Bajwa Mushroom Farm, Kurukshetra	9416037310	4-5	5000
IUMD, Patla Road, Aterna, Sonipat	9416314843	10-15	5000
CS Mushroom Farm, Pehowa, Haryana	9813711111	8-10	15,000
The Gulab Fruit & /vegetable, Aterna, Haryana	8398877515	4-5	10,000
Mr Rajesh, Pehowa/ Farm Fresh, Barhi, Haryana	9255299622	10-15	30,000
Integrated Mushroom Unit, Rai, Sonipat	9416320765	4-5	5000
Partibha Foods, Aterna, Sonipat	9416402766	4-5	5000

* These are rough estimates based on interaction with some of the growers only and not actual production. Data has not been obtained from individual canners. Where no estimate was available, canning capacity of 4-5 ton and/or production of boxes as 5000 boxes has been taken

The costing per can may be less when less than 420 g mushroom are added in a can as there may be slight gain in weight after canning and storage. The cost from washing to carton has been taken as Rs 10. The actual cost may be only Rs 7.50 or so and this price has been taken to cover the unforeseen losses that may occur at various stages of processing.

Table 15: Cost benefit analysis of canning/can

Items	Cost
Purchase price of fresh mushrooms per kg	Rs 65
Percent loss in wt on blanching	35 %
Blanched mushrooms per can	420 g
No of cans from 1 qtl fresh mushrooms	155
Cost of one empty can (800 g) (Rs 13.20)	Rs 13
Processing charges/can (washing to carton)	Rs 10
Total expenditure on one can (Cost of fresh mushrooms + can + labour +label + cartons, etc)	Rs 65
Approx. sale price per can	Rs 68
Expected profit per can	Rs 3

Table 16: Approximate cost on canning at different purchase Prices and loss on blanching

Purchase price of fresh mushroom	Approx. Costing /can with percent loss on blanching as*		
Rs/kg	**33%**	**35%**	**37%**
55	58	59	60
60	61	62	63
65	64	65	**67**
70	67	69	70
75	70	72	73
80	73	75	77
85	76	78	80
90	**80**	81	83

* Depreciation of machinery, buildings, and other finances not included

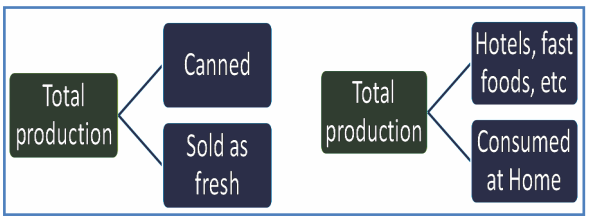


Fig. 50: Where and how mushroom is processed and consumed

As discussed in the next section, the cost of cultivation of mushroom by commercial growers is around Rs 65 per kg. Putting up a canning line will ensure that they may not suffer any loss even when the prices crash to Rs 60 or below in winters. However, canning line may be economical only if it is used throughout the year to can mushrooms or other seasonal products.

(ii) Value Addition

Pickling is one of the common options. At small scale many units in Panipat and some other parts of the state are using small quantity of mushroom for making pickles like; Pachranga (Panipat), Krishna Pickles (Gurgaon), Home Pickles (Jeend), HAIC Pickles (Murthal), Rajesh Pickles (Pehwa), etc. No exact data was available on the firms or quantity that is pickled in the state. Even though there is well established Pickle industry in Panipat, but only limited amount appear to be utilized for mushroom pickle. Number of other options like making biscuits, nuggets, soup powder, mushroom fortified corn extrudates, ready to cook packed/frozen foods, noodles, pasta are there (Annexure 1).

The major problems in mushroom processing industry is the lack of trained manpower. There is no comprehensive manual of good management practices. The canning is done by purchasing the low cost mushroom and there are no specific varieties for canning. In Haryana many growers cultivate button mushroom in winter using long method of composting in which many chemicals are used. Most of the canners purchase mushrooms during winter as the prices in this period range from Rs.60-65/-. There are no specific facilities available for residue analysis. It is important that varieties specifically suited to canning are developed and it is ensured that there are no residues in the canned material.

ToR - IV. Status of Machinery, Inputs and their Suppliers

(i) Status of Supply of machinery and other inputs for spawn

As seed act is not applicable on mushrooms, there is separate nomenclature for the same varieties by each lab. There is need to develop standards and as a first step to register all the labs. Performa developed is annexed (Annexure 6).

Standard design for setting up the spawn lab is available. There are adequate suppliers that provide commonly required machines like autoclaves, boilers, laminar flow, etc (Annexure 7). Some of the machines like grain cleaning, bag filling machines, etc are available in public sector (IIHR, Banglore). For regular production of spawn there is need for grains, glass bottles, polypropylene bags, pp rings, calcium carbonate, calcium sulphate and other chemicals. ICAR-Directorate of mushroom research provides hands-on training on spawn production and also provides Techno Economic Feasibility Report for setting up spawn lab. Basic information about spawn lab and machinery & other inputs required is available on DMR website (www.nrcmushroom.org).

(ii) Status of supply of machinery for mushroom production and processing

Mechanisation is must for composting in a commercial unit as labour is a costly input. A tractor mounted with front-end loader or JCB is required to handle the straw, wet it, turn it, fill it. Conveyer belt and bunker filler/ tunnel filler is required for proper and loose filling of the compost. In case the size of the tunnel is big then it may not be possible to manually spawn the compost and a spawning and bag filling machine may be required. Some of the suppliers in the state are annexed (Annexure 7). Good quality machines are available in Netherlands, China, Poland, Italy, UK, etc. List of suppliers of various items including spawn, compost

machinery, processing, consultancy, training, etc available outside India is Annexed (Annexure 8). The lists given in Annexures 7 and 8 are the ones we could learn from different sources, including interaction with manufacturers and end users, internet, etc. and are only indicative and not any recommendation as it is not a complete list of the suppliers. Consumer is advised to get quotes and look for more firms in the area before arriving at any decision.

Cropping rooms are fitted with Air Handling Units which are being manufactured by number of companies in and around Delhi. For watering, water towers are used in many countries. In India it is done manually by using simple water spray systems.

In addition to this there are petty items like air curtains, filters, knives, cleaning equipments, etc that are required. Machinery for washing, blanching, slicing, canning and sterilization and other Inputs are available in and around the state. Some of firms supplying the items for post harvest processing of mushroom are mentioned in Annexures 7 & 8.

ToR - V. Costs & Returns and Marketing System

(i) Cost of production of button mushroom in different systems

(a) Cost of production of button in commercial production system

Cost of production is a function of BE and number of flushes. While analysing the cost of production per kg in commercial units, there was wide variation due to differences in number of flushes taken per year and Biological efficiency (BE). In one commercial unit cost/kg was Rs 65 at 18% BE & 6 flushes/year. There was another grower taking only four flushes and having BE of 14%. Cost of production in this case was Rs 120/kg that is much below the economic level. Hence, while calculating cost of production per kg mushroom, it is must to mention the BE and number of flushes harvested. Average cost of mushroom production in the state, as informed by most of the growers, was Rs 65 per kg. One of the reasons for higher cost of production, which is almost at par with developed countries, is low productivity. In USA, Australia, Europe BE is around 32-35%, whereas in the state BE of commercial units is 16-18%. So with same inputs but better use of technology the people in West are getting double yield. The only way to reduce cost of production is to increase BE and harvest more flushes within the same time. How the cost of production changes with change in BE and number of flushes has been estimated and is shown below (Table 17). We can see that with 4 crops per year and 17-18% BE, cost of production can be around Rs 100 whereas with 6 crops and BE of 29-30%, it may be only around Rs 40 or so.

Table 17: Estimated cost of production (Rs per kg) by commercial growers at different BE and number of crops per year

Number of Crops/year	Biological Efficiency								
	10%	15%	16%	17%	18%	19%	20%	25%	30%
4	175	117	109	103	97	92	87	70	58
5	140	94	88	83	78	74	70	56	47
6	117	78	73	69	65	62	59	47	39

(b) Cost of production of button in seasonal production system

Seasonal growers take only one crop. However, BE varies from 15-25%. The higher BE is due to the fact that growers while taking only one crop, they keep on taking flushes as long as mushrooms keep on appearing. There are cases where due to disease the BE may go down to 10% or less. Accordingly, the cost of production changes. Most of the successful growers report 22 % BE (Table 18).

The cost of production by seasonal growers is less as they take advantage of the natural conditions to grow mushrooms and do not invest much on electricity. The rental value of land has not been added here. However, the impact of doing so will be 5-7 times more in case of seasonal growers as from a piece of land they take only one flush whereas commercial growers take 5-6 flushes from the same piece of land and accommodate more compost per unit area than it is possible in huts. Interaction with number of seasonal growers indicated that the average cost of production of one kg of mushroom during seasonal cultivation in huts is about Rs 57.

Table 18. Estimated cost of production per kg by seasonal growers at different BE

Components	Biological Efficiency (yield kg/100 kg compost)			
	18%	20%	22%	24%
Hut+Machinery	6.84	6.16	5.60	5.11
Spawn	3.33	3.00	2.73	2.50
Raw material	40.93	36.83	33.48	30.69
Labour	18.80	16.92	15.40	14.10
TOTAL	**69.90**	**62.90**	**57.20**	**52.40**

(c) Cost benefit analysis

In practice most of the commercial growers get about 18% BE and seasonal growers get 22 % BE. Contribution of different components to the cost of per kg production in the two systems is given in Table 19.

As can be seen in Fig. 51, compost, labour and electricity account for 2/3rd of the cost of production in commercial cultivation. It is important that the compost of good quality is produced to ensure proper yield and low cost of production. On one side we need better technology and environmental control to produce more and thereby lower the cost of production, and on the other side, there is need for rationalisation of electricity charges vis a vis other nearby competing states.

As discussed earlier, there are few farmers that produce compost by short method and go for seasonal cultivation. The cost of production per kg mushrooms in their case is at par with seasonal growers making compost by long method as the investment on tunnels for pasteurisation gets compensated by less cost on labour, short duration of compositing, more compost per kg of raw materials, higher and stable yields.

Short method of compositing has better economic and environmental benefits and is more sustainable due to high assured yield with less disease incidence. Hence it will be proper to shift to short method of compositing. Increasing awareness about chemical residues in

long method of compost will also necessitate this change. The only other alternative is to develop compost hubs that may provide readymade compost to growers.

Table 19: Contribution of different components on per kg production in long and short method at BE 22% and 18%

Particulars	Seasonal Growers (Long method composting)	Commercial Growers (Short method composting)
Biological Efficiency	22%	18%
Room +Machinery*	5.50	10.70
Spawn	2.75	4.30
Raw material	33.50	24.60
Labour	15.25	13.75
Electricity	-	11.65
Total	**57.00**	**65.00**

* Based on depreciation value of the infrastructure

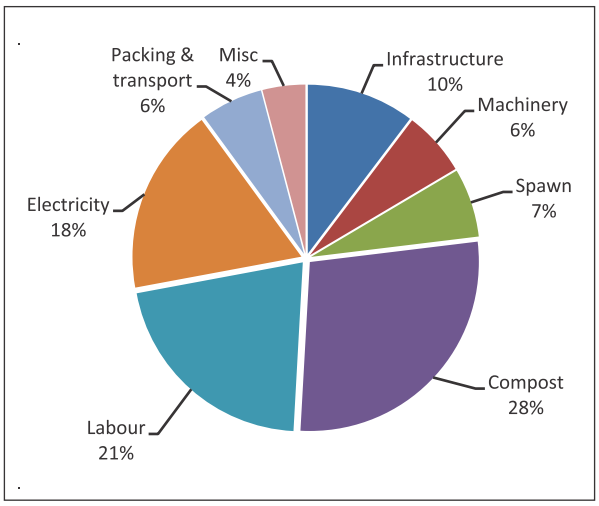


Fig. 51: Relative contribution of different components to total expenses per annum in commercial cultivation

(d) Cost of production of other mushrooms

Considering that there is no large scale cultivation of other mushrooms, it was not possible to work out the cost of cultivation of other mushrooms. Calculations based on the production in HAIC and HAU suggest that due to simple technology and higher BE, the cost of cultivation may be 20-30% less in oyster and milky than that in case of button mushroom.

(ii) Current Position of Marketing System

There is no organized marketing for mushroom. Depending upon the amount of production, farmers sell it in the local markets (district headquarters and blocks) or in metros or big cities. Some of the growers enter into a contract with canners and sell mushrooms at fixed price. Most of the farmers sell their fresh produce in Azadpur Mandi (Delhi).

Depending upon the need and prevailing prices, the mushrooms are also sent for sale to far of cities like Patiala, Chandigarh, Jammu, Shimla, Kanpur, Meerut, Jaipur, Mumbai, Kolkatta, Raipur, Patna, Lucknow, Dehradun, Saharanpur, etc. There are some collection Centres as well, some of which are Reliance Fresh, Easy Day, Mother Dairy, etc.

Very small amount of mushroom is also used for pickling by Agencies like; Pachranga (Panipat), Krishna Pickles (Gurgaon), Home Pickles (Jeend), HAIC Pickles (Murthal), Rajesh Pickles (Pehwa), etc.

(a) Marketing (Fresh and canned)

Exact data on the amount of mushroom sold as fresh or for canning is not available. Based on the interactions with farmers and canners an effort has been made to estimate the amount sold as fresh and for canning in 2017-18 where total production was estimated as 10957 ton (Table 20).

In the absence of proper data, estimates of production and processing may vary by ± 10% or so. Fresh mushrooms are sold in punnets or in polythene bags. About 5% of the mushrooms are B grade and these fetch much lower price. Theoretically, these can be used for pickling or making other products, but only few farmers do it.

Table 20: Estimated amount of button mushroom production in Haryana under different systems/ methods and their sale (in Tons)

Mushroom production	Seasonal growers	Commercial growers	Total (% of Total)
	5000	6000	**11,000 (100%)**
Short vs. Long			
Production on short method	500	6000	**6500 (59%)**
Production on long method	4500	0	**4500 (41%)**
Fresh vs. canning			
Amount sold as fresh	2000	5500	**7500 (68%)**
Amount sold to canners	3000	500	**3500 (32%)**
Punnets vs. loose			
Amount sold as punnets	1300	4000	**5300 (71%)**
Amount sold as loose	500	1200	**1700 (23%)**
Sold as B grade mushroom	**200**	**300**	**500 (6%)**

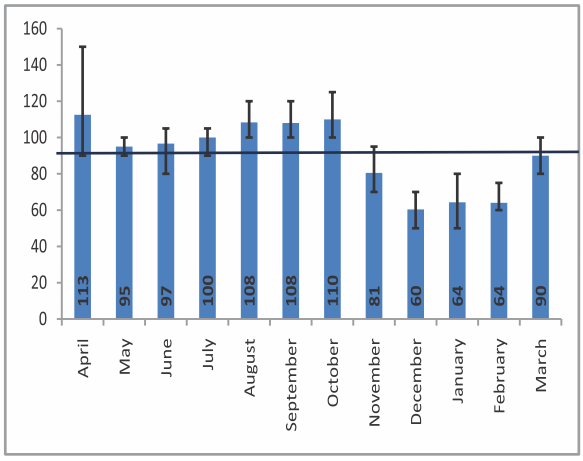


Fig. 52: Average monthly rates of button mushroom in Azadpur Mandi, Delhi (Horizontal line indicates the average annual price of Rs 91/kg)

Monthly data on sale price by three commercial growers and four seasonal growers was collected. The average price obtained by farmers as based on the information provided by the growers is as given in Fig.52 In addition to above, data was obtained from a commercial unit outside Haryana selling mushrooms in Azadpur market, Delhi in last three years (Fig.53). The unit stopped production in winter due to low prices which were not remunerative. Average Rates from April to July are about Rs 115. From August to Oct-Nov it is Rs 110 and Dec to March are about Rs 60-70. Thus average rate for 9 months March to Nov was Rs 110-115, but rates dip in winter when average rate from Dec to Feb reaches 60 to 65. Prices are low in Nov, Dec, Jan and Feb, start picking up in March, peak in April, come down in hot months of May-June and stabilize thereafter up to November.

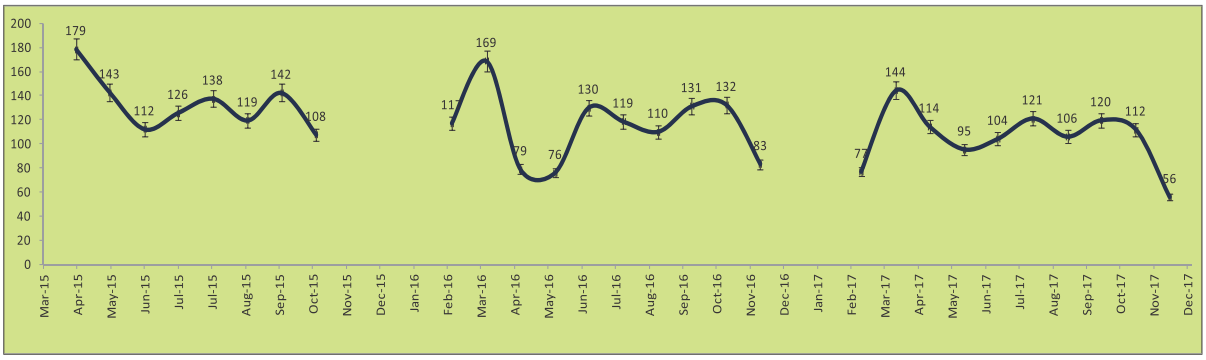


Fig.53. Average price of mushroom when about 70% sold as punnets, 25% loose and 5% as B grade

Data from a commercial unit on sale price of mushrooms as punnets, loose and B grade was obtained for three years. The unit sold about 70% mushrooms in punnets, 25 % loose and 5% as B grade (Fig. 54). The prices obtained for these are shown in Fig.55. It can be seen that punnets fetch better price and seem to be somewhat less beneficial when prices are too low or too high. There seems slight decline in the average price over years.

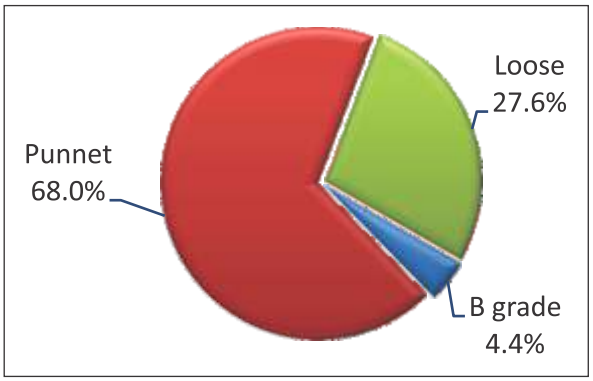


Fig. 54: Relative sale of punnets, loose and B grade mushrooms (2015-17)

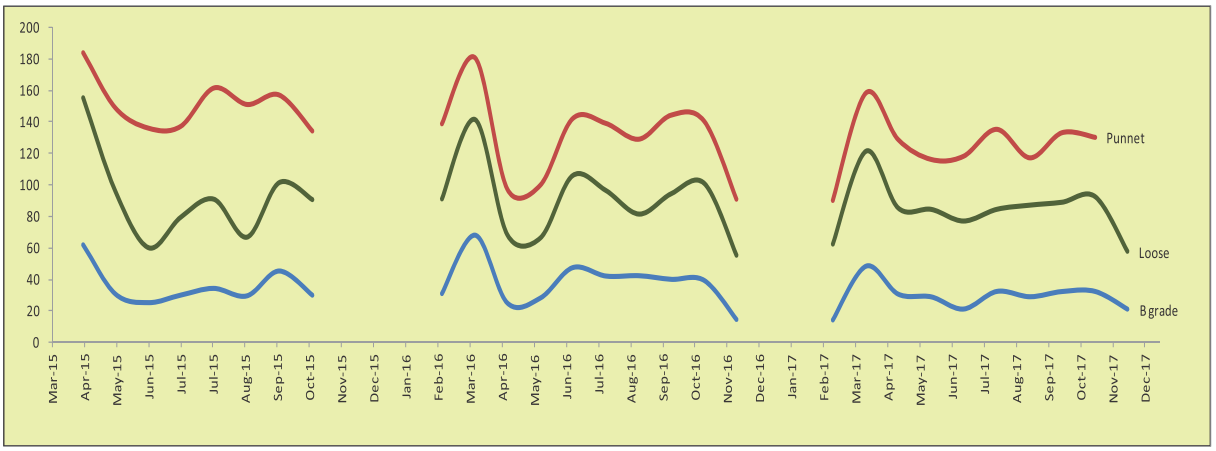


Fig. 55: Price (monthly average) of punnets, loose and B grade in different months from 2015 to 2017 (No sale in winter months due to decline in prices)

ToR - VI. Status of Training Programs and Extension Facilities

HRD is the key to success of any venture. There are very few persons in the govt sector exclusively meant for promoting mushrooms. There are short term trainings of week or 1-3 days organised by HAIC, Murthal, HAU and KVKs in the state. Infrastructure available at KVKs is miniscule and there is no way that famers can be imparted training on modern methods of growing mushrooms. Further, there are no long term courses to develop manpower for commercial units. On one side, it is important to develop pilot scale models and training infrastructure, and on other hand it is important to send trainers for training in Netherlands and China so that modern technology can be percolated in the state.

Status of training imparted by some major organisations in the state is as below:

(i) HAIC Agro R&D Centre, Murthal

Trainings has been a regular feature at HAIC, Murthal (Fig. 56) and in last 10 years there were on an average 20 trainings per year and the average number of trainees/year was 998. HAIC is a major Centre for training of the farmers.

(ii) KVKs

There are 19 KVKs that are part of CCS HAU, Hisar and two KVKs viz; KVK, Ambala and Rewari are with NGOs and KVK Karnal with NDRI, Karnal and KVK, Gurgaon is with IARI, New Delhi. There were no mushroom specific trainings in KVKs of Sonipat, Karnal (NDRI), Faridabad and Mahendergarh. Some of the KVKs like

Kurukshetra, Rohtak, Yamunanagar and Ambala were proactive in providing trainings on mushrooms. In general, each KVK organized one or two trainings every year. The trainings organized by different KVKs are annexed (Annexure 3).

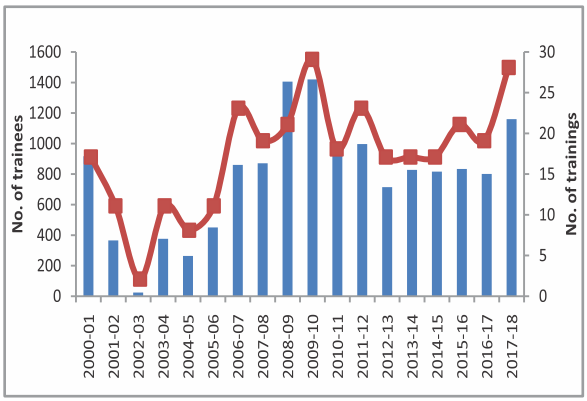


Fig.56: Trainings organized and number of trainees since 2001 at HAIC, Murthal

(iii) CCS HAU, Hisar

In HAU on an average there were four trainings on mushrooms every year (Table 21). In 2017-18 the university experimented with Public/Private partnership for production of compost and spawn and to educate farmers of cultivation of mushrooms by signing MoU with Kurukshetra based progressive farmer Sh. Harpal Singh Bajwa.

(iv) HTI, Karnal

Horticulture Training Institute, which is a part of the Department of Horticulture has a focused mandate of imparting training to the growers and improving the skills of extension personnel. In the last four years the Institute organized on an average three trainings/year on mushrooms (Table 21).

There is no established mechanism to provide consultancy to commercial growers. The limited knowledge is imparted during trainings. At many of the places, the technical competence to advice commercial units is not there as the facilities are not available at KVKs, HTI, etc. Hence, it is important that trainers are sent regularly for refresher trainings/ visits to DMR, Solan; are encouraged to undertake online trainings offered by Netherlands, Australia, etc (Annexure 9) and those who do this, are sent for training to China, Netherlands, Korea, etc. It is also important that scientists/trainers and even farmers are encouraged to attend conferences and trade fairs organized regularly by different mushroom growing countries.

Table 21: Short term trainings by different organizations on mushroom cultivation

Year	HAIC, Murthal	19 KVKs of HAU	HAU at Hisar	HTI, Karnal
2015-16	20	15	4	4
2016-17	18	16	4	1
2017-18	27	21	4	5
Average	**22**	**17**	**4**	**3**

(v) Status of Consumption

There is no data available on consumption of mushrooms in the state. It appears that famers are more interested in producing and selling than consuming locally. Mushroom consumption seems to be restricted to social functions or has not become part of kitchen especially in rural areas. There is need to study factors affecting mushroom consumption which may include: price, season, social status, income, background (rural/urban), lack of clarity about its vegetarian status, etc.

There is need to promote mushrooms by actually preparing and serving the dishes to all the visitors during exhibitions, trainings, melas, etc. Moreover, all the bus stops can display boards of mushrooms and their benefits. There is need for publicity and also need to organise mushroom consumption fairs to promote different types of mushrooms in the state where only button mushroom is being utilised. This will help to educate the people about the health benefits, medicinal value and nutritional facts of mushrooms.

ToR - VII. Status of Research & Development

Research done so far

Research on mushrooms is done almost in all the traditional & agricultural/ horticultural universities. In traditional universities the focus is on diversity or molecular aspects. Some of the organizations doing farmer centric research on mushroom in the state are CCS HAU Hisar, HAIC Agro R&D Centre Murthal, MHU Karnal (planning to start courses on mushrooms), NIFTEM and Others. Research has been carried out at CCS HAU on various aspects ranging from cultivation technologies, genetic improvement, disease management, post harvest management and economic aspects. Some of the areas as indicated by the title of the thesis of various M.Sc and Ph.D students in various departments, name of the student and year are as below:

(i) CCS HAU, Hisar

Thesis Title	Student& Year
Spawn Production	
• Use of agro by-products for spawn production of edible mushroom (*Pleurotus sajor-caju*).	Randhir Singh (1992). 100p
Cultivation technologies	
• Studies on the cultivation of oyster mushroom (*Pleurotus sajor-caju* (Fr.) Singer).	MS Sangwan (1991). 173,xix
• Standardization of cultivation technology of blue oyster mushroom (*Hypsizygus ulmarius*) in Haryana .	Pankaj Kumar Sharma (2016). 32,ivp
• Studies on the cultivation of milky mushroom (*Calocybe indica*) under Haryana conditions.	Kusum Sharma (2002).
• Investigations of cultivation technology of paddy straw mushroom (*Volvariella Volvacea*) .	Pratap Singh Kunal (2010).
• Investigations on cultivation technology of shiitake mushroom (*Lentinus edodes*) (Berk) Pegler.	Vivekananda Nalawade Ajey (2010).
• Studies on seasonal cultivation of *Ganoderma lucidum* (Leyss. ex Fr.) Karst..	Jagdeep Singh (2014).
• Cultivation and post harvest technology of White button Mushroom (*Agaricus bisporus*) (Lange) sing..	Ajay Singh Yadav (1993). 35,vii
• Influence of thermohillic fungi and other factor on yield, quality and shelf life of white button mushroom.	Aman Sharma (2001). 94,x
• Investigation on physiological and nutritional requirements of blue oyster mushroom [*Hypsizygus ulmarius* (Bull.) Redhead].	Rewati Singh Jatav (2008).
Strain evaluation and genetic improvement	
• Evaluation of different strains of high temperature tolerant button mushroom (*Agaricus bitorquis*).	Yogesh Kumar (2005). 48
• Strain improvement of oyster mushroom (*Pleurotus sajor-caju* (Fr.) Singer.) through gamma irradiation.	V. Chandra Sekhar (2005). 76p
• Evaluation of various lignocellulosic products for the cultivation of shiitake mushroom [*Lentinula edodes* (Berk). Pegler	Amoghavarsha Chittaragi (2017) 35, iii

• Development of new strains of shiitake (*Lentinula edodes* Berk.) suitable for sub-tropical and tropical climate.	Rajendra Kumar Samota (2007). 104
Utilizing Spent mushroom substrate of mushrooms	
• Effect of spent mushroom composts on wheat yield and nitrogen transformations in soil.	Sanjay Swamy (2001).
• Studies on management of spent mushroom substrate.	Suresh Verma (2014). 31p
• Utilization of spent oyster mushroom substrate for biogas production and enrichment of biogas plant slurry.	Sonia Kumari (2007). 100p xxiv
• Ethanol production from spent mushroom substrate.	Ritu Grover (2014). 35p
• Spent mushroom substrate utilization using portable technologies .	Sandeep Kumar (2016).
Fungal diseases of mushroom	
• Management of competitor moulds and Post harvest technology of white button mushroom, *Agaricus bisporus* Lange sing..	Ajay Singh Yadav (1997). 106,xiii
• Studies on dry bubble *Verticillium fungicola* (Preuss) Hassebr disease of white button mushroom *Agaricus bisporus* (Lange) Sing.	Parveen Bhalla (1998). 46, vii
• Epidemiology and management studies on bubble disease (*Verticillium fungicola*) [Preuss] Hassebr of white button mushroom.	Narender Kumar Jatav (2008). 93p
• Variability studies in *Mycogone perniciosa* causing wet bubble of *Agaricus bisporus*.	Man Mohan (2016).
• Studies on green mould (*Trichoderma virde*) affecting oyster Mushroom.	Lovkesh (2002).
• Studies on green mould disease (*Trichoderma harzianum*) of *Calocybe indica* (P&C) .	Kundan Kumar (2015). 31p
Mushroom flies	
• Occurrence of mushroom flies and biology of phorid fly, *Megaseia sandhu* Disney on white button mushroom, *Agaricus bisporus* (Lange) Sing.	Amit Aggarwal (2000).
• Management of Phorid fly, *Megasella sandhmi* [Disney] by entomophathogenic nematodes on white button mushroom, *Agaricus bisporus*.	Jagbir Singh Lamba (2006). 53p
• Biology and management of Scarid fly, *Bradysia tritici* on white button mushroom, *Agaricus bisporus*.	B Shivanna (2001).
• Studies on Management of mushroom flies on white button mushroom, *Agaricus bisporus*.	Mandeep (2003). 103p
• Screening of white button mushroom, *Agaricus bisporus* (Lange) Singer strains against mushroom flies and their management through botanicals.	Parveen Kumar (2005). 83, x vi
• Screening of oyster mushroom, *Pleurotus* spp against mushroom flies and their management.	Gagan Joshi (2009). 57p
• Studies on mushroom flies on white milky mushroom, *Calocybe indica*.	Vineet Kumar(2004). 61p

• Studies on insect pests of paddy straw mushroom, *Volvariella volvacea* [Sing] and their management.	Gaikwad Mahesh Balaso (2014).
Nematodes and mites	
• Studies on nematode damaging cultivated mushroom, *Agaricus bisporus* and their management using eco friendly measures.	Gitanjali Devi (1999).
• Life cycle and pathogenicity of *Aphelenchoides swarupi* on *Agaricus bisporus* (Lange) Singer .	Madhun (2015). 44p
• Predatory behaviour of *Fictor composticola* [Khan et al.] and its potential for the management of nematode pests of button mushroom.	Nishi Keshari (2016). 81p
• Studies on abundance and damaging potential of acarine species on mushroom.	Meenakshi Rana (2008). 74
• Management of *Tyrophagus putrescentiae* Schrank(Acari acaridae) in oyster mushroom, *Pleurotus sajor-caju* and its molecular characterization.	Komal (2017).
• Evaluation of damage potential of mite, *Tyrophagus putrescentiae* Schrank in button mushroom, *Agaricus bisporus* (Lange).	Itisha (2017). 54, xip
• Molecular characterization and management of *Tyrophagus putrescentiae* (Schrank) in button mushroom, *Agaricus bisporus* (Lange).	Arvind (2018).
Mushroom processing, nutritional value and mushroom products	
• White Button Mushroom: Its nutritive value, economic feasibility, processing suitability & its utilization.	Monika Sharma (1999). 156, xxvii
• Thermal dehydration of white button mushroom (*Agaricus bisporus*).	Kavita Rani (2000).
• Effect of edible coating and packing methods on shelf life of button mushroom (*Agaricus bisporus*).	Sipna Deshmukh (2007). 83p
• To improve the quality of dehydrated button mushroom (*Agaricus bisporus*).	Vipin Saini (2008).
• Hypocholesterolemic effect and Nutritional attributes of mushroom.	Rajni Goyal (2002). 151p
• Preparation of mushroom powder and its utilization in value addition of noodles .	Duc Doan, Hien (2006). 76p
• Development and nutritional evaluation of value added products using oyster mushroom (*Pleurotus sajor-caju*).	Vimla (2006). 260p
• Nutritional evaluation and shelf life of fresh and dehydrated oyster mushroom.	Parul Bora (2011). 100p
• Utilization of oyster mushroom (*Pleurotus florida*) for operation of value added bakery products .	Anu (2007). 138,xii
• Nutritional evaluation of fresh and dehydrated milky mushroom (*Calocybe indica*) and their utilization for product development.	Himanshi Bhutani (2011).
• Development of convenient and nutritious extruded snacks using cereals, pulses and vegetables.	Yudhbir Singh (2013).

• Development and nutritional evaluation of value added products from Shiitake (*Lentinua edodes*) mushroom .	Jyoti (2015). 88, viiip
Extension research and women empowerment	
• Acceptability of mushroom production technology by farm women.	Anita (2000). 162p
• Feasibility of mushroom enterprises for empowerment of women .	Manju (2009).
• Risk perception and capacity building of women in diversified agriculture for entrepreneurship.	Ritu (2014).
• Viability of income generation through mushroom production and processing.	Sadhana Tripathi (1995).
• Media development and its impact on production and processing of button mushroom in Haryana.	Akanksha (2015). 89p
• Communication pattern for micro-enterprises based on waste management among rural households.	Renu Kumari (2006).
Economic analysis and marketing	
• Economic analysis of mushroom production in district Sonipat of Haryana State.	Ashok Kalra (1993). 43p
• An Economic analysis of production and marketing of mushroom in Panipat District, Haryana .	Parmod Khichi (2009).
• Technological gap and constraints in adoption of mushroom cultivation.	Sube Singh (1998). 91xxvii
• A study on production and marketing of mushroom in Haryana .	Parminder Singh (2001). 63 vi
• An economic analysis of mushroom production and consumption pattern in Haryana.	Mukesh Kumar Jat (2010).

Research done in different departments of CCS HAU has not been translated into package of practices. The package of practices has also not been properly scrutinized. For example, in the Rabi segment there is a mention of cultivation of paddy straw mushroom that requires temperature of 30-40°C and also that of *Pleurotus* that requires 25°C for its cultivation. There are few species of oyster that can be grown at lower temperatures but the same has not been specified. Even though, button mushroom has been included but only long method of composting has been mentioned and there is no mention of the modern cultivation technologies. Normally, many chemicals need to be incorporated in long method. It appears that to comply with the guidelines of label claims, the mention of use of any chemicals in long method of composting has not been made. There is a need for a review of all the work done in the university and development of inter-departmental research programme for holistically addressing different problems of mushroom cultivation in the State.

The All India Coordinated Research Projects on Mushroom - CCS HAU, Hisar

AICRP on Mushroom came into existence during VI Five-Year Plan on 01.04.1983 with its Headquarters at ICAR-Directorate of Mushroom Research, Solan (HP). The Director, ICAR-DMR, Solan also functions as the Project Coordinator of the project. Initially the AICRP-M started with six Centres. In subsequent plans more centres were added and in XI Plan CCS HAU Hisar was included as coordinating centre.

CCS HAU Hisar Centre, established in the year 2009, is having good spawn lab equipped with most of the equipment required. Compost production, pasteurization facilities and temperature-controlled growing-rooms also exist for button mushroom cultivation. The University has good facilities and expertise to develop different types of value added products of mushroom, which can go a long way to popularize and aid in marketing mushrooms in India.

Centre has been regularly evaluating strains of *Agaricus bisporus, Pleurotus* species, *Volvariella*, Shiitake and milky mushroom, evaluating the technologies developed at DMR, Solan like Zero energy poly tunnel method for making compost for button mushroom, technologies related to dehydration and processing of mushrooms, etc. The centre has been undertaking extension activities related to imparting trainings, organising fairs and disseminating the knowledge about mushrooms through various print and other audio-visual media. The centre also provides feedback on the problems faced by the farmers which include disease incidence of wet bubble and yellow mould, and fly incidence at farms of seasonal growers.

Strength of this Centre lies in the fact that it is located in the mushroom bowl of the country and can play a pivotal role in developing the mushroom industry not only in the State but in the neighbouring States as well. Availability of raw materials and awareness of the masses for mushroom in their day-to-day life is another advantage for this Centre. Further, it is located near NRC, Equines and has other establishments keeping horses. This makes horse manure easily available. However, majority of the farmers cultivating button mushroom with low –input technology has resulted in occurrence of many diseases and pests causing frequent crop losses/ complete crop failure and hence this may be a formidable challenge for further growth of the industry in the area, which may even require diversification of the mushroom portfolio of the State. Since it is a white button mushroom bowl of the country, efforts need to be made to introduce and popularize tropical mushrooms to break the mono- culture scenario to manage the present diseases through crop-diversity and also enlarge mushroom marketing-period so as to augment the income of the farmers.

Since mustard stalk is available in plenty at cheaper rates, efforts should be made to cultivate different mushrooms on this substrate so that the cost of production may be reduced. The wet bubble and yellow moulds are the major threats to button mushroom industry in the State and hence a comprehensive programme should be taken up to wipe out these two diseases from the State.

HAU has got very good Home Science Department and good work on value addition of mushroom has been done in the past. The Centre should work more on post-harvest techniques in view of huge production of Button mushrooms and its falling prices during winters. With available Infrastructure, the Centre should augment the supply of quality spawn and pasteurized compost as well substrates of other mushrooms to the needy growers. Centre should also popularize short method of compositing instead of promoting long method as the experiments using this method have been stopped at all the centres.

(ii) HAIC Agro R&D Centre, Murthal

HAIC has MoU with various agencies like University of Science & Technology, Murthal, IIT (CRDT), New Delhi, etc and has been conducting research in collaboration with various organisations & has been publishing the results in scientific journals. Some of the important outcomes of the work done in last few years are evident from the publications of HAIC like:

HAIC Agro R&D Centre, Murthal

Title	Reference
Spawn	
Effects of qualities of Calcium Sulphate & Calcium Carbonate in spawn production of *Agaricus bisporus*.	Ajay Singh *et al.*(2008) Mushroom Research. 17(2):71-73
Studies on incidence of spawn contaminants & economic losses in spawn production of button mushroom, *Agaricus bisporus*.	Ajay Singh *et al.* (2009) Mushroom Research. 18(1):17-19
Standardization of parameters for cost effective quality mushroom spawn production.	Ajay Singh *et al.* (2016) In 19th ISMS, 29th May – 2nd June 2016 at Amsterdam
Button & Oyster Mushroom	
Status & scope of mushroom cultivation in Haryana-constraints and future outlook.	Surjeet Singh & Ajay Singh (2014) In 8th International Conference of Mushroom Biology & Products, 19th-22nd Nov. 2014 at Delhi.
Prevalence of competitor & parasitic moulds during milky & white button mushroom cultivation in Haryana.	Ajay Singh *et al.* (2010) Mushroom Research, 19(1): 45-49
Evaluation of anti microbial potential of fruiting body extracts of *Pleurotus ostreatus*.	Kiran *et al.* (2012) Intl. J Micro Res. Tech (IJMRT) 1(4): 391-400
Milky Mushroom (*Calocybe indica*)	
Yield, nutritional composition and antioxidant properties of *Calocybe indica* cultivated on Wheat straw basal substrate supplemented with nitrogenous tree leaves.	Rathore *et al.* (2018) Waste and Biomass Valorization. 1-9 1877-2641 ISSN.
Utilization of locally available biomass for the cultivation of *Calocybe indica* mushroom.	Ajay Singh *et al.* (2016)In 19th International Society for Mushroom Science (ISMS), 29th May – 2nd June, 2016,Amsterdam.
Effect of supplementation, casing material & substrate preparation method on *Calocybe indica* production.	Ajay Singh *et al.* (2010) Mushroom Research. 19(2): 86-89
Isolation and purification of peroxidase enzyme from edible fungus, *Calocybe Indica*.	Vishaka *et al.* (2016). Mushroom Research. 25 (1) : 29-34
Enhancement of nutritional and nutraceutical properties of *Calocybe indica* by UVB irradiation	Himanshi *et al.* (2016)In 19th ISMS, 29th May – 2nd June 2016, Amsterdam
Shiitake (*Lentinua ededes*)	
Studies on Biological Efficiency of various strains of Shiitake mushroom	Sujata *et al.* (2018)In Global Congress on Biotechnology, Nanotechnology, Energy and Environment, 25-26 April, 2018, DCRUST, Murthal
Recent development in cultivation technologies of Portobello, Shitake & King Oyster	Jitendra Kumar &Yadav Ajay Singh In "Trends & Innovation in Mushroom Science" ICAR-DMR

	Solan, 27-28 April 2017
Development and evaluation of value added biscuit from dehydrated Shiitake (*Lentinula edodes*) mushroom.	Jyoti Singh *et al.* (2016) Intl J.of Current Research. 8 (03): 27155-27159.
Nutritional and sensory attributes of cookies as influenced by addition of *Lentinula edodes* powder	Ajay Singh *et al.* (2016)In 19th ISMS, 29th May – 2nd June 2016, Amsterdam
Studies on effects of supercritical Carbon dioxide extraction on yield and antioxidant activity of *Lentinula edodes* extract.	Shalinee *et al.* (2017) Research Journal of Pharmaceutical, Biological and Chemical Sciences. 8(4): 1144-1154
Medicinal Mushrooms	
Medicinal Mushrooms as a source of Novel Functional food.	Parsad *et al.* (2015) Intl J of Food Science, Nutrition and Dietetics. ISSN 2326-3350
Biochemical estimation of wild *Ganoderma lucidum* collected Form different agro-climatic zones of Haryana.	Sonia Takshak *et al.* (2014) Int J Pharm Bio Sci. 5(2): (P) 143-151
Separation and determination of antimicrobial activities of targeted ganoderic acids from *Ganoderma lucidum* (Lingzhi).	Shweta *et al.* (2013) Mushroom Research. 22(1):63-69

AICRP on Mushroom – HAIC Murthal

This Centre was adopted as a Co-operating Centre under AICRPM w. e. f. 1st April 2009 and upgraded to Coordinating centre in XII Plan. Haryana is the only states in the country having two coordinating centres. The Centre produces and sells spawn and spawned-compost to more than 300 farmers every year and follows it with necessary Advisory and Testing services. The Centre has adequate Infra-structural facilities, which was built under the consultancy provided by DMR, Solan at an initial cost of Rs. 3.00 crores.

Perhaps this centre has the most advanced and huge spawn lab in the country in public sector having all the necessary equipment. A large scale compost production unit along with four Phase-I bunkers and two pasteurization tunnel of 25-30 ton compost production each also exists. Besides these, environment control test-cum-demonstration mushroom growing facilities are also available. Centre has been regularly evaluating strains of *Agaricus bisporus, Pleurotus* species, *Volvariella*, Shiitake and milky mushroom, evaluating the technologies developed at DMR, Solan like Total indoor compositing, Zero energy poly tunnel method for making compost for button mushroom, and others as agreed to during regular workshops of the mushroom workers of all centres.

The centre has been undertaking extension activities related to imparting trainings in a big way and has emerged as the centre imparting training to maximum farmers in the state. In addition to organising fairs and disseminating the knowledge about mushrooms through various print and other audio-visual media, the centre is providing spawn and spawned compost on commercial scale and is also providing help to the farmers for providing testing facilities for the compost. The centre also provides feedback

on the problems faced by the farmers which include diseases incidence of Plaster moulds, *Coprinus* in *Calocybe indica*, wet bubble and yellow mould, and fly and mite incidence at farms of seasonal growers of button mushroom.

The Centre has achieved self-sufficiency in running most of its outreach programmes and with coming under the folds of AICRPM, the research aspect has also received due support. Due to monoculture of button mushroom chiefly on Long Method of Compost, diseases like yellow mould and wet bubble have recently become causes of concern and need to be addressed urgently. Of course, its linkages established with ICAR-DMR under this project and various other agencies like NIFTEM, state universities and state department of Horticulture provide an opportunity to help the growers by better technologies/strains and approaches to processing and marketing. Technologies related to cultivation of tropical and sub-tropical mushrooms need to be popularized among the button mushroom growers to avoid monoculture practice. The Centre should take-up projects on management of Yellow Mould and Wet Bubble diseases.

Testing of samples

There are very few testing facilities for compost or spawn in the state. HAIC has been providing sample testing facilities throughout the year since last many years. As can be seen in the Fig 57, there is increase in number of samples during winter season. This is due to start of cultivation by seasonal growers.

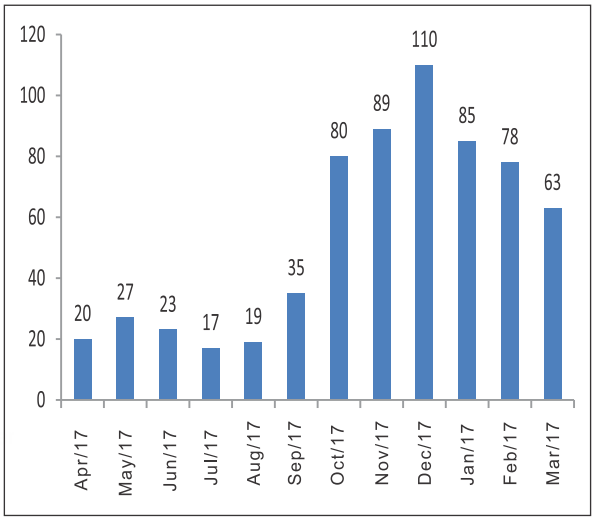


Fig. 57: Compost samples tested in different months at HAIC Murthal in 2017-18

ToR - VIII. The Linkages

The major organisations involved in mushroom cultivation, i.e. HAIC, Murthal, CCS HAU, Hisar, MIDH and Deptt. of Horticulture have informal linkages. The linkages at places are more theoretical and competitive instead of being practical and complementary. Within HAU, many Departments have worked on different aspects of mushroom cultivation, processing and marketing, and also utilization of spent mushroom substrate in different ways. The knowledge generated has not been integrated and reflected in the development programmes of the University. HAIC, Murthal is one of the coordinating Centres of ICAR-DMR, Solan and it has functional linkages with ICAR-DMR, Solan, DCR University of Science & Technology, Murthal, NIFTEM, Sonipat and IIT, Delhi (CIRD). At national level linkages of HAU and HAIC were linked to DMR, Solan for the purpose of Research. There were no international linkages with respect to mushroom research and development. However, scientists from HAIC have been informally interacting with international organizations and scientists during international conferences and symposia.

The Sum Up

There have been many small units coming up and production is picking up. For better promotion of mushrooms there is need for systematic and integrated efforts in the areas of HRD, awareness generation, R&D, hubs for quality seed (spawn) and compost production, and scheme/ policies to popularize mushroom cultivation. By doing so farmers will be able to earn more from limited area in a sustainable manner and the end result will be production of quality food with health benefits from agro-residues. The compost left after cultivation can be recycled into the soil thereby improving soil health and promoting lesser use of fertilizers.

The Haryana Mushroom industry is not well-structured and has grown in bits and pieces. There were individual efforts by farmers as a result of which Haryana growers have developed local technology. The technology based on long method of compositing may not be sustainable in the long run. There is need for concerted and integrated efforts by farmers, entrepreneurs, marketers, scientists, policy makers and administrators to popularize new technologies and promote production and consumption, to plug the loop holes and to learn from success of other countries and our failures.

Lately there has been an order in the progress and the farmers are becoming aware of the scope and needs for the growth of this venture. As a result their demands and expectations from scientists and policy makers are on increase. It is important to support this unique venture, which though a component of horticulture, is unique in many ways. Mushrooms can be cultivated on limited piece of land, provide employment and social status to youth and women and help in total recycling of agro-wastes and their cultivation can be done throughout the year under controlled conditions. Mushrooms are a source of quality protein, vitamins, and minerals in addition to many novel compounds having various health benefits. The increasing population, shift in the way we look at agriculture, limited land availability, changing food habits, urbanization and demand for functional foods will require attention towards ventures like mushrooms and other secondary agriculture activities. Funding of R&D activities and farmer friendly policies are a must and will play a significant role in this success of mushrooms in the state.

Looking to the future, it is clear that there are significant benefits and opportunities for continued growth of mushrooms in the state. To ensure proper markets it is important that mushrooms become a part of our kitchen in both rural and urban areas and don't just remain an item in the menu of social functions. Market research worldwide shows that we can use strong health messages to drive increased consumption.

It is against this background that an effort has been made to develop a roadmap and provide list of actions required in the next section in this document for growth of mushrooms in Haryana. This is based on formal and informal interactions with all stakeholders and end users. Such a strategic plan will help in clearly visualizing the financial, academic and industrial needs important for the growth of mushrooms in the state and country. It calls for increased resourcing from both public and private sector. Continued investment in R&D and marketing is essential to stimulate consumer demand. Without such investments and proper policies, profitability will be seriously challenged. There is need for regular review and course corrections as we move forward. This tempo and drive will be required in the coming years to ensure that people living in rural areas stay connected with agriculture and take pride in being farmers.

ToR-IX. Proposed Strategies and Policy Interventions

As a first step, we have analysed the strengths and weaknesses of the State and is presented below as SWOT analysis. Feed back as obtained from different stakeholders has been ummarized and based on this we have proposed some actions that are required for promotion of mushroom in the state.

SWOT Analysis - Haryana

Strengths

- **Base material availability**: Abundant supply of agro-wastes. Raw materials required for mushroom cultivation such as wheat straw, paddy straw, bran, poultry manure and gypsum are available in plenty in Haryana and adjacent states.
- **Manpower**: Educated youth, women, innovative farmers in rural areas -Rural labour force potential
- **Land**: Land resources available for diversification into mushrooms. Small scale and fragmented agricultural holdings. Low soil quality at places.
- **Govt support**: Increasing support of Ministry of Agriculture from Centre (MIDH) and state
- **Health Food**: Mushrooms are a great, healthy, clean product for consumption and available all year round. Trend in demand is upward and high potential in respect of mushroom consumption by youths
- **Markets**: Well established markets like Azadpur Mandi. Most of the sales are local and minimal fresh imports or international competition
- **R & D support**: HAIC Agro R&D centre Murthal, CCS HAU Hisar in the state and ICAR-Directorate of Mushroom Research at Solan (HP) nearby are an advantage for mushroom growing farmers in Haryana

Weaknesses

- **Lack of Market intelligence**: Limited mushroom marketing networks and lack of up-to-date data on market restricts the ability to gain insights on how to expand in all available sales channels
- **Unstable and declining prices**: Not much improvement in farm gate prices relative to cost of production in last few years. High price fluctuations and dip in prices in winter due to seasonal growers
- No existing brand names for sale and no system of awareness generation about other mushrooms
- **Awareness**: Lack of scientific understanding of the growing process. Lack of guidelines/GAP or exposure to international mushroom cultivation practices.
- **Lack of standard designs**: Inadequacy of proper designs and on-farm extension services due to limited number of trained extension workers. Low emphasis on technological development on mushroom production
- **Increasing input costs**: Increasing labour costs, low cost machinery not available, Difficult for smaller farms to compete
- **Inadequate standards**: No mechanism of traceability, product certification as organic or spawn certification. Inadequate standards for mushrooms and mushroom based food products.
- **Transport:** Lack of cold chain combined with low shelf life

- **Consumer awareness**: Lack of awareness among consumers, no effort to generate awareness about health benefits, cooking methods, etc to promote consumption
- **Lack of cultures**: Dependence on outside agencies for supply of quality cultures. R&D in this area is nonexistent in the state. No assured availability of quality spawn with all details of its protocols (temperature requirement, carbondioxide senstivity, etc)
- **Limited finances**: High dependency of rural income sources on agricultural activities
- **Policies**: Problems regarding integration of mushroom industry into farming system, ambiguity of it being an agricultural activity,
- High electricity rates, lack of assured electricity and absence of specialized markets
- **Linkages**: Inadequate coordination between public institutions
- **Manpower**: Lack of proper scientific input and trained man power, especially for commercial units
- Myths and misinformation about mushrooms
- Limited literature in local language on both cultivation and consumption.

Opportunities

- **Organic farming**: Existence of potential for promoting organic agriculture through use of spent mushroom substrate
- **Increasing demand of mushrooms**, particularly in urban areas through promotion programs
- **Scope for value addition** and making product available to caterers of large functions
- Targeted and effective **marketing and promotion program** to continually increase consumption of different types of mushrooms at home
- Boost mushroom **consumption in summer**
- Grow **demand for fresh** loose/bulk mushrooms
- Better dissemination of information to growers/industry,
- Creation of **Centre of Excellence/** mushroom knowledge city providing cross-sector research.
- Develop models for **two crops of button mushroom by seasonal growers** by promoting use of short method compost and addition of spawn running facilities in existing infrastructure
- **Closeness to huge consumer markets** like Delhi, Sonipat, Chandigarh, etc. hence huge opportunities to expand mushroom production.
- **Increasing consumer consciousness** and demand for healthy quality and organic products
- Increasing interest in protecting and improvement of **environment**
- Progress in production and processing technologies, institutes like NIFTEM in the state
- Increasing concern of government for the empowerment of youth and women
- Introduction of special courses on mushroom in the school and at university level

Threats

- Rising labour, power availability and costs
- A potential scare related to spread of misinformation about mushrooms being unsuitable in summer or turning poisonous on opening, or being non-veg food
- Ineffective marketing and promotion programs especially in summer
- Increased disease potential due to old method of compositing and inadequate awareness about hygiene
- Lower prices in winter. The white button mushroom produced in winter seasons by seasonal growers leading to glut and price fall in the market making cultivation uneconomical for commercial units.
- Reduced profitability due to increase in input costs
- Inadequate infrastructure for post harvest handling and value addition in mushrooms in the state.
- Lack of diversification of mushrooms as majority growers take up white button mushroom production and stop the mushroom farming after the end of the winter. This leads to disturbance and discontinuity in market supply chain.
- Migration of young from rural areas, increasing pressure of rapid urbanization and industrialization
- Growing inter-regional development disparities - variable costs like electricity, fuel charges, etc
- Spawn production labs fully operational only for 3-4 months. Hence viability low until RTFs/ spawn of other mushrooms is popularized.

Goals & (Actions)

- **Doubling mushroom production of the state in five years** (infrastructure development and awareness generation about how to grow mushrooms)
- **Achieving diversification** in mushroom and mushroom products (introduction of new species and focus on PHT)
- **Increasing mushroom consumption** by awareness generation about nutritional benefits, medicinal benefits, ecological benefits and methods of cooking mushroom through press, TV, consumption fairs, etc

The Feed back

Interaction with farmers, entrepreneurs, spawn producers, processors, machinery suppliers, canners, bankers, scientists and other stakeholders helped us to understand and prioritize the core areas that are required to be addressed to give boost to mushroom production and consumption in the state.

Most of the farmers felt that there is no state level body /association representing all the stakeholders. This lack of coordination leads to exploitation of the growers in Mandis (Markets) and hinders growth of the industry. Growers felt the need for cooperative marketing for better price control and it should be done with bar coding based sale and direct transfer of money and shift from quantity to quality; long to short method of compositing, seasonal to commercial production. In the absence of govt supported/approved association, growers do not have any say in the policy formulation or fund utilization for mushroom related activities.

All farmers felt the need for awareness generation among consumers about health, medicinal and ecological benefits by print, audiovisual media, by introducing chapters at school level on mushroom cultivation and health benefits and development of product standards. Farmers were of the view that considering the benefits of mushroom cultivation in recycling agro-wastes, promotion of manure based farming, production of quality food and other benefits, this promotion may be taken up by the state. Individual farmers or associations are not rich enough to do it. Indigenous recipes may be developed and popularised. Mushrooms or mushroom products like pickle, biscuits may be included in mid day meal.

All commercial growers were unanimous in their view that commercial units need assured electricity at reasonable rates that are at par with Delhi or Utrakhand. Farmers further felt that electricity may be given 24 x 7 and at the agricultural rates or at the rate at which the state is purchasing the electricity. Many of them opined that growing mushroom is no way different than growing vegetables and hence this activity may be considered as agriculture for income tax purposes. Commercial units also faced the problem of trained manpower and hence need for restructuring training programmes or starting courses in university for developing such resource. There was a general view that short term trainings are not adequate enough and KVKs and many other organisations imparting training themselves are not equipped with adequate facilities.

Finance was the limiting factor in establishment of units. Farmers felt the need for review of NHB/NHM schemes, Kisan (mushroom) credit cards (with increased limit of 10 lakh per acre, 6 month short term loan), review of bank financing at lower rate of interest for setting up mushroom unit or interest free loan without subsidy, acceptance of agriculture land for loan as collateral security for loan, subvention on interest of the bank of Agri-finance, etc. Farmers wanted rationalisation of commission by commission agents and opening of farmers outlets.

Growers wanted one stop solution, better replicable farm designs, machinery on hire purchase basis, certified spawn of standard quality, hubs for production of quality compost and spawn, promotion of solar energy based gadgets in mushrooms, supply of ready to fruit bags of mushrooms other than button, need for farmer and machinery supplier databases for better dissemination of new developments, cost benefit analysis for fixing MSP, Establishment of processing units in the state, development of cold chain and so on.

Some of the other suggestions were: J form for vegetables and mushrooms may be provided by commission agents; CLU should not be mandatory. Farmers raised questions about applicability of income tax rules on income from mushrooms. The following reference came to the notice of the committee.

http://itatonline.org/archives/wp-content/uploads/Inventa-Mushroom-Agri-Income-SB.pdf,

It is the Case of M/s. Inventaa Industries Private Limited, Hyderabad vs Dy. Commissioner of Income Tax, Circle-2(1), Hyderabad in the Income Tax Appellate Tribunal Special (B) Bench, Hyderabad the judgment as decided on 9th July 2018 says that :

As basic operations are performed by expenditure of human skill and labour on land by the assessee, which results in the raising of the 'product' called "Edible white button mushroom" on the land and as this product has utility for consumption, trade and commerce, the income arising from the sale of this product is agricultural income and hence exempt u/s 10(1) of the Act.

A Vicious Cycle

Given below is vicious cycle (Fig. 58) which every farmer faces not only for mushroom but for all the components of farming system. Less income leads to fewer inputs in field the result of which is less output which gives less income. For further growth in agriculture we need to diversify and break this cycle. There is need to focus on all aspects and address issues at each step in the cycle instead of focusing only on one arm. For example, providing subsidy alone may not be of use till we provide better cultivation technology and value addition/marketing infrastructure/prices. The policy, technological and institutional support in unison is must to adress the issue for farmers' distress.

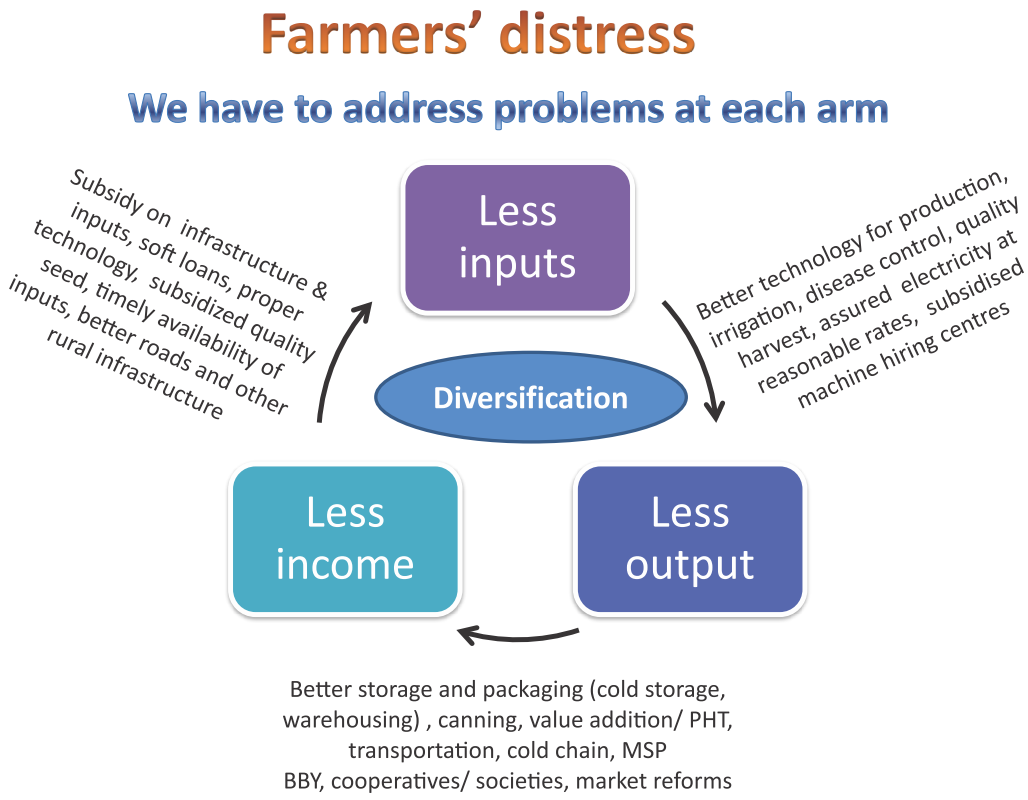


Fig. 58: A vicious cycle of low income, low input and low output

Actions Required

Structural Changes in the system

Agro-waste management must for next revolution in Agriculture

Managing waste for useful purposes is going to be an important topic in coming days. Some of the options of generating wealth from the waste are:

- Cultivating mushrooms (agro-waste used directly or after aerobic composting (Sheds in one acre require about 100 ton of paddy straw which is produced in 6 acre land).
- Energy Production (bio-fuels (cellulose to bio ethanol), biogas, use in furnaces as briquettes/white coal for generating heat, electricity)
- Making compost (vermi compost, biodynamic compost/bio fertilizer, spent mushroom substrate) for improving soil health, disease control and organic farming
- Isolation of biochemical's (enzymes, organic acids, etc)
- Direct use (as mulching, bedding, making huts, onion and other storage structures)
- For Industry (Card board, ply, paper industry, packing material, building materials, bricks, etc). Machinery for bailing and processing of agro-wastes will be required.

The idea is to develop economic model by holistic recycling of agro-wastes. The next revolution in agriculture is in learning efficient use of agro-wastes. Mushroom cultivation has much wider scope as it can utilize raw materials like straw, chicken manure, etc. This may be possible only when there is focused approach, and hence need for a separate department.

A Separate Department dealing with Recycling of Agro-wastes

In the present set up of department of horticulture, mushrooms will remain at relatively low priority as the focus of horticulture is on fruits, vegetables, poly-houses, etc (In China mushrooms are 5th most important agricultural commodity and there is separate ministry for edible fungi).

Major structural changes will be required to make the farming remunerative. There is need to create a separate department dealing with recycling of agro-waste by pooling people from department of agriculture, horticulture, pollution control, environment, etc. It may deal with issues related to problems of straw burning, methods and machinery for agro-waste collection and storage, etc.

It may consist of three sections

- In situ recycling : SMS (Straw management system), zero tillage sowing, mulching, bailing
- Ex situ recycling: Using straw for making boards, packing material,

electricity and other products, compost, animal feed, etc

- Promoting Mushroom cultivation & consumption: All aspects of mushroom including RTF bags

A separate section promoting Mushrooms (in collaboration with Department of Horticulture) with clear-cut allocation of funds and a senior officer (Deputy Director) as in-charge of the section will be necessary for greater focus on mushroom development.

Mushroom Advisory Committee

State level committee to advise govt.

At the state level there is need for Mushroom Advisory Committee (MAC), a committee to provide advice to Govt on expenditure on the Mushroom activities and other policy as well as R&D initiatives required. Strategic Plan needs to be approved by this committee that can serve as a base document for the preparation of Annual Action Plans. The committee may have five members representing various sectors including farmers.

State Price advisory Committee/ Trade Board

As MSP in highly perishable crops like mushrooms may not be easy to implement, a state price advisory committee or fair trade board having representation of both farmers and traders can negotiate minimum purchase price and maximum sale price. This will require institutional support as well. Institutional support in terms of publicising the cost of cultivation (including cost of land and margin for risk of crop failures) and actual mean purchase price by traders will mean greater transparency in the marketing chain and it will help to generate awareness among consumers. Members of state level advisory committee can be part of this committee/board. Farmers from cooperatives/ FPOs and trader representatives may also be member of this group.

Haryana Mushroom Growers' Association

Mandatory registration to association to avail any benefit

There is need for Haryana Mushroom Growers' Association (HMGA), not-for-profit, member-based organisation representing the interests of all seasonal and commercial mushroom growers and others in the supply chain and associated with the industry. It may be mandatory for every person to be part of this association so as to avail any benefit related to mushroom both financial and technological. President or his nominee may be member of mushroom advisory committee.

Rationalisation of Input costs- Electricity

Farmers will prefer assured and continuous electricity at reasonable rates over free electricity for few hours

Commercial cultivation requires continuous electricity at reasonable rates as generating electricity through generators is 3-4 times costly and the electrical expenses are an important contributor to the production. The electricity tariffs in Haryana are much higher than adjoining States and there is need to rationalize it and possibly provide it at agriculture rates so that the growers can compete in the market. It may be added here that t Azadpur Mandi is a common market for the adjoining States as well. It may not be done only for mushrooms, but all hi-tech agriculture that require continuous electricity (All mushroom activities like spawn, compost, cropping & canning, tissue culture, poly-house, CA stores, etc).

Income tax on mushroom production

Income from mushroom cultivation is an agriculture income

In the light of the judgment of case of M/s. Inventaa Industries Private Limited, Hyderabad vs Dy. Commissioner of Income Tax, Circle-2(1), Hyderabad in the Income Tax Appellate Tribunal Special (B) Bench, Hyderabad, where income arising out of sale of button mushroom in a commercial unit has been ruled out as agricultural income, the state government may take up the case with centre for general guidelines applicable everywhere and bring out mushroom cultivation out of the ambit of income tax. The arguments made in this case are applicable to all methods of cultivation of button mushroom and also to other mushrooms.

Research & Development

Case studies

Case studies where mushrooms have transformed villages or where there were failures may be undertken and research programmes and recommendations may be modified accoridnly.

It is important to commission study on reasons of failure of projects in and around the state to avoid similar mistakes. The reasons that may be analysed include:

- Was mushroom growing not profitable?
- Was there inadequate scientific/extension/subsidy support?
- Policies were not supporting the trade,
- Raw materials/labour/cans/market outlets not available,
- Are the short term solutions of rotational growing sustainable in the long run?
- Is seasonal cultivation more economical than commercial growing and will it continue to be so in future?

Focus on strain development

Greater focus on research areas for indigenous strains suitable for our conditions. Need for developing and promoting specific strains suitable for canning. The existing strains may be classified as per need, season, etc and given uniform nomenclature with help from DMR, Solan.

Varieties for canning	Need to identify and promote strains suitable for canning, freeze drying and other products. Lot of research has been done in management of diseases, cultivation of other mushrooms, use of SMS, economic aspects, value addition, etc. There is need to collate and summarize the information generated so far so that it can be translated into recommendations to the farmers.
Holistic models for complete recycling of agrowastes	Using Spent Mushroom Substrate for making manure and improving soil health or using it for making casing or replacing part of compost ingredients or making vermi-compost or as pot mixture, etc. There is need to develop integrated models with mushroom as component of the farming system
Models based on solar energy& water harvesting	Develop pilot scale models demonstrating use of solar energy so as to promote solar applications in mushroom cultivation. Both MIDH and HAREDA can give 35% subsidy each on solar gadgets. Studies on use of solar water heaters for pasteurisation and centrifugal machines for drying of straw after hot water soaking for oyster mushroom Developing ready to fruit bags; as such facility can also help in promoting urban horticulture. As water in some areas is not of good quality, water harvesting structures can be integrated with mushroom unit. There is need to develop good agricultural practices and incorporate them in the package of practices recommended by CCS HAU, Hisar.
Label claims for pesticides	No pesticide has label claim for use on mushrooms in India. Accordingly, data may be generated for registration or alternatives may be provided to growers.
Develop/ modify machinery for regional needs	Institutional development of technology and machinery as per our conditions; Need for mechanisation as labour cost is increasing and availability is decreasing. HAIC/ University may import portable pasteurisation tunnels, bunker/tunnel filling line, machinery and liquid spawn technology for pilot scale demonstration, and develop indigenous machinery. A group of experts may visit China/ Netherlands/ Korea for procuring the latest machinery that can be upgraded here as per our needs and also used for supply of ready to fruit bags of specialty mushrooms.
Cost benefit analysis will be must for MSP	Need for cost benefit analysis, market analysis and feedback analysis of trainings. Undertake case study of Badhana, Suba mushroom and other units that have closed down.
Review of research done at HAU till now	Review of research done at HAU, Hisar and revision of package of practices in the university and also on website of department of Horticulture. With establishment of new university on Horticulture, major

mushroom activities can be shifted there and it may collaborate with HAU in areas not covered in the new university.

Popular articles

The researchers may regularly write popular articles for farmers and consumers to increase awareness about cultivation methods and consumption. This may need work on development of novel products.

Action for Centre of Excellence

Centre with replicable pilot scale facilities, trained man power for one stop solutions

Considering that mushroom cultivation is hi-tech venture and most of the units are copying other units, which themselves are poor performers, it is important to establish Centre of Excellence along with Pilot scale projects. The centre can provide state of the art trainings, provide ICT solutions and even consultancy to the commercial growers. This centre can be established in the MHU, Karnal as state of the art facility that can be replicated by farmers for commercial cultivation. Separate course on mushrooms may be started in new University of Horticulture (MHU, Karnal).

Facilities for production of ready to fruit bags of specialty mushrooms like shiitake, king oyster, etc will help to promote diversification as it may not be possible for small growers to establish such facilities.

Spawn production lab needs updating and technology for liquid spawn may be imported for state of the art facility.

Facility for quality as well as residue analysis of the mushrooms may be strengthened/developed at this centre. The centre may be the primary knowledge centre on all aspects of mushroom R & D and may coordinate with state departments for promotion of mushrooms including its consumption.

ICT for helping the farmers

Farmers need instant help during compositing, especially Phase II. Also, there is not much time for disease management once it appears. Hence need for online one stop solutions for all problems including farm designs, machinery, inputs, compost formulae, etc. Lot of information has been generated in the university on various aspects and it needs to be collated and put on website. Centre of excellence, in addition to pilot scale demonstration unit, may impart on-line training, impart 3-6 month courses and also on-line solutions to problems of farmers. The website may include:

- Information on cultivation of different mushroom
- E-training courses on mushroom cultivation & other horticultural crops (preference in regular training courses to those who have undergone E-training)
- E-books, ask an expert
- Disease analysis system, on line solution

- Nitrogen calculator with details of N value of different ingredients
- Mushroom recipes
- Profit calculator/ cost benefit analysis
- List of registered suppliers of inputs, spawn, compost, i.e. database of farmers, entrepreneurs, machinery suppliers, marketing outlets, canneries and other stake holders
- Standard farm designs, government subsidy schemes, standard Techno Economic Feasability Reports for spawn, compost, cropping, PHT
- Models promoting use of Solar energy, water harvesting and Good Agricultural Practices
- Detailed standards for mushroom spawn, compost fresh mushrooms and mushroom products, etc

Trainings and HRD

HRD is the missing link

Human Resource Development is the key and an important missing link not only for the growers but also for the trainers. We need to educate all categories of people. It is important that trainers are firstly encouraged to visit commercial units within the country, undergo online training courses provided by various agencies in Netherlands, Australia, etc. and finally undergo comprehensive training in Netherlands, China and other countries depending upon the type of mushrooms to be cultivated. For example, *Morchella* is an important mushroom in our country and yet not cultivated.

The training for its cultivation is being imparted in China, Australia, etc. Likewise, *Cordyceps* is an important medicinal mushroom and at present training for its cultivation is provided in Thailand and some of the private growers in Uttarakhand, Haryana and Rajasthan have taken this training and have started production of this mushroom. There are no specialized courses to generate manpower required by the commercial units.

Certificate course of 3 to 6 months

There is need for 3-6 months certificate courses to educate the workers. MHU can even consider starting diploma/ degree courses with specialization in mushrooms.

Only those organisations that have infrastructure or preferably pilot scale facilities to expose the farmers to the modern technologies may impart training. Here too, the period of training may be increased and wherever possible, certificate courses of 3-6 month may be started.

Restructure training courses

There is need for starting 3-6 month certificate course and comprehensive syllabus for regular training at MHU covering engineering aspects of farm design, machinery, air conditioning, fans, insulation, air circulation; basic lab techniques of measuring pH, nitrogen, ammonia,

carbon dioxide, etc. in addition to cultivation techniques. Training lectures should cover topics like CLU, pollution control certification, etc. Such courses are important for developing trained manpower for commercial units.

There should be special training programme for the products of mushroom and also on canning. Trainings may also cover things and certificates required (like FSSAI), pollution certificates and how and where to get these.

Mushroom education at school level

Courses focusing on specific mushrooms or even specific topics of mushrooms. For example separate courses on spawn production, compost making, processing, cooking, etc. Mushroom course/ chapter in 10th class along with practical may be introduced.

On-line training modules and apps for mobile phone

In the changing scenario of communication systems, online training on mushroom cultivation is important for trainers and trainees (Annexure 9). We may also develop elementary online courses in Hindi/English and passing these basic online courses can be a prerequisite to regular three month proposed training at MHU.

There is need to develop apps for

- Information on cultivation of different mushroom
- Disease analysis system, on line solution
- Nitrogen calculator with details of N value of different ingredients
- Mushroom recipes
- Profit calculator/ cost benefit analysis
- List of registered suppliers of inputs, spawn, compost
- Standard farm designs, government subsidy schemes, etc

Visits in India and abroad

Participation of growers, scientists, experts and officials in National and International conferences and exhibitions is a must. Visit of group of farmers and officials to Netherlands, China (China produces 87% of world's mushrooms, cultivates 60 type of mushrooms) will provide the necessary exposure. It is also important to educate the policy makers for promotion of mushrooms in the country.

Educate bankers too

Education of bankers in understanding mushroom projects and simplifying loan procedures is also necessary. That may include meeting with SLBC, visit of bankers to small medium and large scale mushroom units. (Regular bank-wise data on funding of mushroom projects). Regular feedback on number of projects financed and problems faced by them will be desiarbale.

State/NHM

Spawn

Register spawn labs, produce ready to fruit bags and develop spawn standards

There is need for setting up 3-4 modern spawn labs in the state and renovation of existing spawn labs to meet the demand of quality spawn. These labs may also produce ready to fruit (RTF) bags of other mushrooms like oyster, king oyster, shiitake, etc. This will ensure that labs are operational throughout the year and it will also help in promoting other mushrooms and develop peri-urban horticulture.

Considering that there are no clear provisions in law at present for registration of spawn labs, or applying rules of seed act on spawn, or even release of mushroom variety, it is important that mechanism may be developed to register all the spawn labs and all the labs in the state must follow some minimum standards (see Annexure 6). It may also be **mandatory to put tag on the spawn bags indicating date of inoculation, variety, batch number, etc** and there should not be any arbitrary names of the cultures/varieties as is practiced by many labs. It is happening so, as there are no rules to release the variety with respect to mushrooms and the seed act rules don't apply here. In fact, there are no listed spawn standards as a result of which, farmers do not have any protection against supply of poor quality spawn. Hence, need for developing **spawn standards.**

The technologies being used in all the spawn labs in the state are just amplification of laboratory methods. Technology for spawn production at commercial scale as used internationally by many labs like Sylvan is not available in the country. We also do not have a **liquid spawn** production technology which is commonly used in China, Japan, Korea, etc for cultivation of mushrooms other than button mushroom. A long term plan may be developed to ensure spread of mushrooms in the state. Due to locational advantage, the state can be a leader for whole of the country and provide spawn of button mushroom and other mushrooms, and RTF bags to all the parts.

Compost

Promote short method of compositing & steps towards Phase III compost

In whole of Europe, no grower makes his own compost. The substrate for button and other specialty mushrooms is prepared by few agencies. There is need to establish hubs for compost production in each district and supply short method compost on subsidized rates to replace use of furadon based and less productive long method of composting. Instead of spawned compost as sold at present, it may be better to sell spawn-run compost. Providing fully spawn-run compost (Phase III) will mean assured production and also two crops in winter by seasonal growers instead of one as is the practice at present. It is important that subsidy may be

provided only for short method of compositing, including trays as provided in state plan.

Subsidy only on short method compost only in IHD schemes

It is important that susidy may be provided only for short method of composting including trays as provided in state plans. In state plan subsidy may be extended to other mushrooms also and here the state may supply Ready to Fruit (RTF) Bags of mushrooms other than button mushroom. This will require establishment of compost hubs at 3-4 places in the state and incubation facilities at all districts to meet the demand of the growers. There is a need to shift from quantity to quality; long to short method, seasonal to commercial production. Under SC & SP, subsidy may be applicable only on short method of compost.

Short method compost details on website

The website of department of Horticuture may be updated by highlighting the benefits of short method of compositing and latest technology of mushroom cultivation along with farm designs in lieu of long method may be provided. Similarly, we may also promote selling of unwashed mushrooms

Methods of steam pasteurization of casing soil may also be included.

Promote Paddy straw for growing mushroom s

Promote use of paddy straw for compost production, by providing benefits to those who use it. Promotion of bailing of straw will ensure easy storage and quantified usage during compost preparation. Paddy straw can be used for developing RTF bags for other mushrooms as well.

Crop Production

Extend subsidy scheme to ex-servicemen

Separate scheme for ex-servicemen on the the lines of SCSP Scheme in the action plan of Dept of Horticulture may be made part of the state plan. Special training for army men/ defence personel before retirement

Provide reports for standard farm designs

Standard Techno Economic Feasibility Reports (TEFRs) for spawn unit, compost, cropping, processing may be developed and provided at notional cost to the growers for availing benefits of subsidy. The report may contain detailed designs and protocols for different steps including disease management and also details of the machinery. This will ensure that farmers get benefit without hassles and there is uniformity in the structures. Information regarding all the suppliers, purchasers, equipments, etc should be displayed on the website.

SOPs for increasing Biological efficiency from 16-18% to 32-35%

Considering that the production of mushroom in kg/100 kg compost is only 16-18 kg in commercial units against 32-35 kg in developed countries, there is serious need for introspection of the models of mushroom cultivation that are promoted among the growers. We are still promoting long method of compositing in our training programmes just because the training institutes themselves do not have any short method composting models. Emphasis on automation of environment

management in commercial units, cook out for disease management, proper designs of rooms, adequate air circulation and so on is missing.

In the long run, greater emphasis on better technologies to enhance biological efficiency (productivity) will help in bringing the cost of production down; govt support in procuring and disseminating such technologies, and subsidising the cost of up gradation of commercial units will be a win win solution.

Supply of Ready to Fruit bags to promote diversification

Considering the climate and demonstrations at HAIC, Muthal, it is amply clear that many other mushrooms can be cultivated in the state. Climate is also suitable for cultivation of other mushrooms. For promotion of other species, on one side it is necessary to provide ready to fruit bags and on the other hand it is important to create awareness about its consumption. Automated systems for production of such bags/bottles on large scale are available in China, Japan and Korea. Govt/NHM may import such systems for large scale production of bags including use of liquid spawn technology at one centre in the country and may develop incubation centre at 4-5 places in the state.

Custom hiring centres

Custom hiring centres for mushroom equipment may be established at 5-6 places. Horticulture dept may procure machines in at least two districts (Sonipat and Panipat) or promote mechanisation.

Databases for growers, promotion

Database of farmers, entrepreneurs, machinery suppliers, marketing outlets, canneries and other stake holders. Need for data bases of growers along with information on number of huts, amount of mushroom produced, years since working on mushrooms is also needed.

Promotion of Consumption

Promote health benefits Remove misconceptions

Promotion of health (nutritional and medicinal) benefits of mushrooms through print and audio-visual media, **TV jingles/models**, messages on bus stands/ buses, awareness at school level, consumption fares, may be done by the state. Mushroom based **indigenous recipes** and recipe books in Hindi and organisation of consumption fairs (in collaboration with Tourism department, Hospitality organisations, event managers, private companies/ canners, mushroom growers, etc.) to generate awareness about how to cook and eat different mushroom is equally important because if the people don't know what to do with mushrooms, they will not purchase it.

There is also need for support for opening farmer's outlets for wider availability and cheaper prices and promote novel mushroom products, mushroom pickles, and introducing mushroom products in mid day meals, etc. There is also need for awareness about mushroom and mushroom products as supplements and medicines.

The product standars may be developed. It may be mandatory to display amount of mushroom in the product (dry or wet wt basis) and nutritional components of mushroom products.

Only vegetable having Vit D

During these promotional campaigns, in addition to the novel health benefits, we may also remove misconceptions (like open mushrooms are poisonous) We may also promote mushrooms other than button and also that mushrooms as the only vegetable having vit D and also a novel vegetarian source of vitamin B_{12} (Annexure 10)

Data on consumption patterns

Targeted promotion will require market research on relationship of age, sex, social group, location, background, etc on consumption behaviour. Hence scientific analysis of the consumption behaviour is needed. The general perception was that consumption may be more in younger generation and mushroom is more commonly consumed at social functions or in hotels instead of homes, particularly in rural areas. This needs to be documented properly.

Restructure data sheets for species-wise data collection

At present data is collected only for button mushroom. Using the database of farmers and other stakeholders, detailed data may be collected not only for button but also for other mushrooms. A proforma for data collection is given in Annexure 11. There is also need for change in the method of reporting from trays to kg/100 kg compost or straw. Month-wise and species-wise production data will be desirable. Data on number and production capacity of units/ mushroom huts in the state, type of compost, spawn suppliers, etc can also be collected (Annexure 11).

Promote Peri-urban Horticulture

For urban areas need for:
Readymade spawned compost/ RTF bags. Home kits/ State of the art facilities. On line booking
Convenient containers–plastic-trays that can be transported & stacked
Strains with wide adaptability to temperature and humidity
Specifically designed do-it-yourself booklets.
Methods to convert the spent compost into pot mixture
Specifically designed small poly tunnels for roofs with multiple uses

Revise MIDH subsidy

Revision of 40 % subsidy under MIDH for 55 lakh to 75 lakh project for establishment of spawn lab or compost unit or cropping unit or any combination thereof instead of integrated unit. This flexibility to set up any one component or more using subsidy on 75 lakh is must to set up viable unit. Subsidy may be given only once. State policy on insurance of sheds

Bar coding and direct money transfer

Collection Centres for mushrooms may be established. While doing collection, bar coding of each box having details of material, account number of farmer may be done so that as soon as the box is sold, money is directly transferred to the account of the farmer. We need to promote digital agriculture and procurement infrastructure. APMC system may need revision.

State advisory price committee

A state advisory price committee or fair trade board having representation of both farmers representing mushroom cooperatives/ FPOs and traders may negotiate minimum purchase price.

Mushroom Cooperatives

Collection centres

Collection centres, cold chain facility and promotion of mushroom processing technologies are necessary for better price to the growers (For development and promotion of cold chain for sale of mushroom, provision for subsidy is already there in MIDH).

Packing and cooling system on field are important to ensure supply of good quality mushrooms to the market. Mushroom cooperatives/ FPOs can play an important role to achieve these goals.

Considering that mushroom cultivation is a labour intensive crop and is grown in rural areas, half labour should be under MNREGA

Cooperative processing

Processing unit by Govt or cooperative societies. According to some growers 60 to 70% of mushroom in Sonipat is canned

Mushroom cooperative societies/BPOs may be formed/ promoted for better price control in the market.

Banking

Fixed cost of project as collateral security

Fixed cost of the project may be added in the collateral security for the purpose of loan. Agriculture land should be accepted for bank loan. Considering that interest rate on FD is less than what farmers pay (in some banks, FD is made for the subsidy), the interest paid in addition to the subsidy may be compensated.

Interest free loan for 5 years instead of subsidy

Mushroom cultivation should come under Kisan Credit Card (KCC). Interest subsidy may be increased for mushroom (Say 10 lakh/ acre for seasonal cultivation for one year). Presently it is for loan up to 3.00 lakh under KCC

Rate of interest should be low for mushroom unit as initial investment is heavy. Interest free loan for five years without subsidy may be more useful.

Linkages

Linkages must for synergy

The collaboration among University and various Departments related to Agriculture/horticulture should be practical and complementary rather than theoretical and competitive. Regular feed back from producers, farmers, canners and other stakeholdrs is important.

Import technical knowhow and explore possibility of international linkages/collaborations

Others

Recommendations of National symposuium at HAIC, Murthal

A National Symposium on Trends & Innovations in Mushroom Production Technologies, Diversification, Processing and Consumption was held at Agro R&D Centre, Murthal from 31 January to 2 February 2019. Number of recommendations that emerged from this symposium are of direct relevance to the state and are annexed as Annexure 12.

Salient Recommendations

- Separate department for agro-waste management may be created with three sections viz., in-situ management, ex-situ management and mushrooms
- Establishment of centre of excellence at MKU, Karnal for pilot scale facility demonstration, advanced long term trainings, online training and ICT based solutions for the farmers and other stakeholders. Major focus on HRD of the trainers; training only where state of the art facility exists.
- Rationalization of electricity rates and assuring continuous supply.
- In the light of Inventaa vs. Dy. Commissioner of Income Tax, Hyderabad, the issue of income from mushroom cultivation as agriculture income may be taken up with centre for issue of general guideline applicable everywhere.
- Revision of subsidy under MIDH from 55 lakh to 75 lakh for establishment of spawn lab or compost unit or cropping unit or any combination thereof instead of integrated unit. This flexibility to set up any one component or more using subsidy on 75 lakh is must to set up viable unit.
- Separate scheme for ex-servicemen on the the lines of SCSP Scheme in the action plan
- Review of research done at HAU, Hisar and revision of package of practices in the university and also on website of department of Horticulture. With establishment of new university on Horticulture, major mushroom activities can be shifted there and it may collaborate with HAU in areas not covered in the new university
- Research on engineering aspects like, design of tunnel, fan, rooms etc for our conditions,
- Promotion of short method of compositing and mushroom diversification; supplying of only short method compost under various state plan schemes, provide RTF bags of other mushrooms as well, provide partial subsidy for making huts in 2nd and 3rd year also where subsidy is provided for making hut. Till hubs for short method compost get created, the cost of transport of such compost to far of places may be borne by government.
- Develop standard designs and provide standard Techno economic feasibility reports to avail subsidy facilities under MIDH schemes
- Develop standards for spawn, compost, mushroom products and registration of spawn/ compost production units with the state for quality control
- Import technology, machines, fine tune it; develop international linkages
- Promotion of mushroom consumption by the state through audio visual means, print media, messages on bus stands/ buses, awareness at school level, consumption fares, novel mushroom products, mushroom pickles, introducing mushroom products in mid day meals, etc
- Collection centres, cold chain facility and promotion of mushroom processing technologies are necessary for better price to the growers.
- Knowledge upgradation of growers as well as persons working in the field. It may be apt to divide the state into 3-4 sub eco regions and a post of mushroom expert for each region may be created.
- Compost testing facilities may be developed in each district along with collection centres and facilities for storage of spawn, compost, spawn run of the bags, etc

Technologies suitable for Haryana as per DMR, Solan

1. Strains suitable for Haryana

Few strains developed by DMR are suitable for the Haryana mushroom growers

1. Button Mushroom:

a) DMR-button-03: The stain has white cap with dome shape and average cap size is 4.3 cm. The cap surface scaly. The gill color is whitish pink while veil opening is late. The average stipe diameter is 1.8 cm with stipe length 1.7 cm. The temperature required for spawn run is 24 ± 2°C and for fruiting 17 ± 1 °C. The yield of this strain is 20 -22 kg/100 kg compost.

b) DMR-brown button-06: The cap colour is brown and dome shaped with average cap size is 4.2 cm. Cap surface is scaly with pink gill colour. The veil opening is late. Stipe diameter is 1.9 cm and stipe length 1.8 cm. Temperature required for spawn run is 24 ± 2°C while fruiting require 18 ± 1 °C . The yield is 22 -25 kg/100 kg compost.

DMR-03

DMR-06

c) NBS-5: The cap colour is browning and bruise resistance hybrid variety and can yield up to 21-24kg/100kg compost

d) NBS:1- The cap colour is browning and bruise resistance hybrid variery and can yield up to 22-25kg/100 kg compost

NBS-1

NBS-5

2. Paddy Straw Mushroom (*Volvariella volvacea*)

a) **DMRO-247**:The strain has oval fruit body shape with size Fruit body size 5-7 cm long × 4-5 cm wide. The fruit body weight is 14-18 g and fruit body colour is Light brown. The yield of this strain is 12-38 kg/100kg dry compost/different substrates.

b) **DMRO-484**: The strain has oval fruit body shape with size fruit body size 5-7 cm long ×3-5 cm wide. The fruit body weight is 14-20 g and fruit body colour is whitish or greyish. The yield of this strain is 14-40 kg/100kg dry compost/different substrate.

3. Shitake mushroom

a) **DMR- Shiitake 38**- The shape is spherical with dark brown. The outer surface is light brown white scars uniformly distributed throughout the cap. The cap diameter is 6.5-8.0 cm with stipe length is 5-6cm. The fruit body weight is 40-45 g. The yield of the strain is 31-40 kg/100 kg on saw dust.

b) **DMR- Shiitake 388s**- The shape is spherical with initial colour pale yellow in colour that turns light brown with maturity. The ring of white scars on the cap is present. The Cap diameter is 6-7 cm with stipe length 5-6cm. The fruit body weight is around 35-39 g while fruit body colour is light brown. The yield of the strain is 22.3-43.9kg/100kg wheat straw.

4. Milky mushroom

a) **DMR- Milky 334**: The cap is spherical and white with long stipe. The cap diameter is 7-8 cm. The stipe length is 11-12 cm. The fruit body weight is 33-38 g. The fruit body colour is white with yield around 74-82 kg/100 kg of dry wheat /paddy straw.

5. *Macrocybe* mushroom

a) **DMR-*Macrocybe*** -1: The temperature required is 25-35ºC with R.H. 70-80%. The Light requirement is around 8-10 hours (more than 100 lux). The CO_2 required is less than 800 ppm. The average fruit body weight is around 20-40 g with B.E 40-70%. The mushroom does not have the off smell and this strain can be stored up to 10 days in refrigerator and 3-4 days at room temperature (20- 26ºC).

Production Technologies of ICAR-DMR suitable for Haryana

1. Composting and casing technologies for button mushroom

a) **Zero-energy poly tunnel (ZEPT):** This technology is successfully used for compost preparation for cultivation of white button mushroom by many resource poor farmers in Bihar and UP, Haryana and HP states. It is a novel composting technology for small-scale seasonal button-mushroom growers. This composting technique also gave good results for oyster and milky mushroom.

b) **Casing material Standardization**: Casing is standardized for different regions such as burnt rice husk, rotten FYM, leached and fermented coir pith, spent mushroom substrate, their combinations, etc. Selection of Coir pith + FYM (1:1,v/v) and spent compost (2 yr old) as the promising casing soil materials.

c) **Substrate standardization**- Local ingredients such as mustard straw, soybean straw, sugarcane bagasse, paddy straw identified for button mushroom compost for different regions and formulations developed.

2. Cultivation technologies for other mushrooms

a) **Cultivation technologies for pink oyster *Pleurotus djamor* var *roseus* (pink oyster) standardized:** This species is pink in color and fast

growing mushroom. Its spawn run is complete within 13 days with 10 percent spawning rate at dry weight basis. The texture of fruit body is hard compared to other species. This species require 25-32 °C for spawn run and 22-28°C for fruiting. In addition to this other varieties of *Pleurotus* can also be grown in Haryana as per the temperature of the month.

P. eryngii
10-15 °C

P. osteratus
15-18°C

P. florida
18-24°C

P. cornucopia
24-27 °C

P. pulmonarius
24-28 °C

P. djamor
24-32 °C

b) **Indoor cultivation technology of Paddy Straw Mushroom** (*Volvariella* spp): standardized on paddy straw and Cotton Ginning Mill waste as substrate with high biological efficiency. Substrate is composted for 4 days outdoor and then pasteurized/conditioned for 4 days in the cropping room itself. Beds were prepared with 20 kg wet substrate on the shelves of iron racks. During spawn run, temperature of 32±2ºC was maintained in the cropping room.

c) **Cultivation technology for *Macrocybe giganteum* and *Calocybe indica* standardized:** The mushroom can be grown on a wide range of substrates. Substrates exposed to rain or harvested prematurely (green colour) are prone to various weed moulds, which may result in crop failure. It can be grown on straw of paddy/wheat/ragi/maize/bajra, cotton stalks and leaves, sugarcane bagasse, cotton and jute wastes, dehulled maize cobs, tea/coffee waste, etc., However, cereal straw (paddy/wheat), which are easily available in abundance are favored. Pastruization is done as oyster mushroom while casing is required.

d) **Cultivation technology of *Agrocybe aegerita* standardized:** *Agrocybe aegerita,* commonly known as black poplar mushroom grows mostly on poplar and willow wood from spring to autumn. *A. aegerita* has unique flavour, high nutritive value and many medicinal values. It can be grown on a variety of substrates as mentioned for milky mushroom cultivation. Substrate has to be sterilized in the autoclaves. The wheat straw is soaked overnight for 16-18 h and later remove the straw and drain out excess water. Mixing 4-5% wheat or rice bran on wet weight basis is done upto2 kg in polypropylene bag and autoclaved at 15 p.s.i.

for 1-2h. Spawning of the substrate is done after cooling @ 4% aseptically and incubate at 25-30°C for spawn run for 20-25 days. The bags are given Cross cut or slits and hanged for fruiting at 25°C with 85-90% RH. One bag (2 kg) yields about 500-600 fresh mushrooms.

e) **Development of low cost ready to fruit bag**: Low cost RTF technology is developed on oyster mushroom in 2017 by ICAR-DMR. The RTF is wheat straw based technology containing 2kg of wet substrate. The spawn requirement for bag is 4 % of wet weight basis. The bags come with handy hanging options so that it can be hanged in rooms. On optimum temperature and humidity, each bag can produce 300-500 g of mushroom in three flushes. The fruiting requires temperature around 24℃ and humidity around 80-85%. After pin head formation, humidity is created by spaying the water on fruit body and bags so that fruit body won't dry.

3. Management of diseases and pest

a) **Management of yellow mould**- in Button mushroom through incorporation of Single super phosphate experiments at Murthal and Ludhiana centres showed that mixing of granular single super phosphate @1% in the compost at the time of spawning enhanced the yield near to the uninoculated control and restored the production of button mushroom.

b) **IPM Mushroom Flies Management-** Composting on cemented floor, maintenance of proper moisture in compost and proper pasteurization i.e. 59C for 6 hours with ample aeration, proper pasteurization of casing at 65C with 65% moisture, treatment of empty room with 2% formalin, application of malathion on walls @ 0.01% after 7 day of casing, Application of deltamethrin @ 0.01% on walls after first flush, application of dichlorvos @ 0.01% on walls after second flush, spray 150ppm bleaching powder for controlling bacterial diseases, use light trap for monitoring and controlling fungal gnats, cook out (Chemical/ steam), drenching with 2% formalin before disposing off the bags or Maintaining 70°C temperature inside rooms for 8-10 hours effectively controlled major disease (wet bubble) and mushroom flies.

c) **Use of UV fly catcher for management of mushroom flies:** Ultra Violet (UV) fly catcher (365nm) was placed at different heights (on the floor, 3", 5"). It was observed that placement of UV fly catcher at 5' height proved highly effective for trapping and killing of mushroom flies. Placement of UV fly catcher on floor proved ineffective. Fly catcher is normally operated only during night hours.

d) **Spent Button Mushroom Substrate utilization and recycling**- can be reutilized for fresh compost preparation for button mushroom. The technology has been standardized and evaluated. The addition of spent mushroom substrate in the nutrient poor soil leads to an improvement in soil texture, water holding capacity and nutrient status. Spent mushroom substrate incorporation in soil does not have any adverse effect on its alkalinity while, its amendment in soil leads to an increase in both pH as well as the organic carbon content.

Post-harvest technologies suitable for Haryana

Mushrooms with its huge health and nutritional benefits can solve many problems of under-nutrition and malnutrition. Despite this fact mushroom cultivation and its utilization is not catching up fast because of its highly perishable nature. Thus there is an urgent need of developing technologies to process mushrooms immediately into value added products which will not only cater to the protein and micronutrient requirement but at the same time will solve the problem of postharvest losses of mushrooms. Following are some technologies to process mushrooms into value added products with extended shelf life.

1. Preservation of Mushrooms

a) **Drying of mushrooms :** Drying is one of the most important methods to decrease the water content and the dried produce can be utilized for preparing a number of value added products. Mushroom contains about 90 % moisture at the time of harvesting and is dried to a moisture level down below 10-12 per cent. Besides sun drying, mushrooms can be dried in cabinet dryers at a drying temperature of 55-60ºC which gives dehydrated final product of lower moisture content with longer shelf life and better quality. The dehydrated mushrooms can be easily powdered and used in several food formulations including instant soups, bakery products etc.

b) **Canning of mushrooms :** Canning is a technique by which the mushrooms can be stored for longer periods up to a year and most of the international trade in mushrooms is done in this form. Mushrooms can be canned whole, sliced and stems and pieces as per demand. The canning process can be divided into various unit operations namely cleaning, blanching (5-6 minutes at 95-100ºC), filling into can with brine solution (2 % salt with 0.1 % citric acid or 100 ppm ascorbic acid), sterilization by heat (118ºC), cooling, labeling and packaging.

c) **Steeping preservation of mushrooms :** This method is simple and economical and the mushrooms can be preserved for short period by steeping them in solution of salt or acids. Solution consisting of 2 % sodium chloride, 2% citric acid, 2 % sodium bicarbonate and 0.15 % KMS is used for steeping preservation of blanched mushrooms for 8-10 days at 21-28°C

Dried Mushroom

Canning of Mushroom

Steep preservation

2. Value added products of mushrooms

Various value added products such as mushrooms pickle, jam, sauce, candy, preserve, chips etc. can be prepared from fresh mushrooms whereas from the dried mushroom powder value added products like instant soup mix, bakery products, papad, nuggets etc. may be prepared. Many such value added products of mushrooms have been developed by post-harvest section of ICAR-Directorate of Mushroom Research (Solan) and can have direct application in Haryana

Conventional Products

a) **Mushroom Pickle:** Pickling of mushrooms is an easy home scale process for preservation of mushrooms to a value added product of high market acceptability. For preparing mushroom pickle, mushrooms are washed, sliced and blanched for 5 min in 0.05% KMS solution. The blanched mushrooms are washed in cold water for 2-3 times and the excess water is drained off. Then the mushrooms are subjected to salt curing process, in which 10% sodium chloride is added and kept overnight. The excess water oozed-out of mushroom is removed on the next day and spices & preservatives are mixed to the desired taste and quality of mushroom pickle. To 1 kg mushroom various spices *viz.* turmeric powder (20g), black mustard seed powder (35g), red chilli powder (10g), cumin seed powder (1.5g), carom seed (10g), nigella seed (kalonji)(10g), fennel seed powder (1.5g) and

mustard oil (200ml) are added to prepare tasty pickle. Acetic acid and sodium benzoate within the permitted limits are used as preservatives. This pickle can be stored up to one year in the airtight bottles.

b) Mushroom Biscuits: Both button or oyster mushroom can be used to prepare delicious and nutritious mushroom biscuits using ingredients *viz*., refined wheat flour (*maida*) & mushroom powder (in 80:20 ratio), sugar (30%), ghee (bakery fats) (45%), baking powder (0.6 %), ammonium bicarbonate (0.3%), salt (0.6 %), milk powder (1.5 %) and vanilla essence (0.02%). For making biscuits all the dry ingredients are finely ground and sieved. Then fat and sugar are mixed well for 5-7 minutes using Dough kneeder. These ingredients are then added to dough kneeder with other dry ingredients for dry mixing of 20-25 minutes. Thereafter, water is added to make dough cohesive and homogenous and mixing is continued for 10-15 minutes. Then dough is kept for 10 minutes covered with wet cloth. Thin sheets of dough (1.25 cm thick) are made and cut into different shapes of biscuits using different steel dies. These raw cut biscuits are then baked in hot oven (at 180°C) for 20 minutes and after cooling biscuits are ready for packaging.

c) Mushroom soup powder: For preparing mushroom soup powder, dried oyster or button mushrooms are finely ground in a pulveriser to pass through 0.5 mm sieve. This mushroom powder (20g) is then mixed with milk powder (25g), corn flour (40g), salt (8g), sugar (3g), black pepper (2g) and oregano (2g). This soup mix has to be mixed with 6 times quantity of water for the preparation of good quality mushroom soup with characteristic aroma and taste.

d) Mushroom nuggets: For preparation of mushroom nuggets, mushroom powder (dried and coarsely ground mushrooms) is mixed with the Black gram (*Urad*) dhal powder (1:8) and a paste is prepared by adding required quantity of water. Salt (2%) and red chilli powder (1%) are added to the prepared paste and round balls of 2-4 cm diameters are made. The prepared balls are spread over a steel tray and are sun dried. These mushroom nuggets can be straightaway deep fried and used as snacks or can be used in vegetable curry preparation.

Mushroom Biscuit | Mushroom soup powder | Mushroom nuggets | Mushroom papad

e) Mushroom papad: Papad is a thin, crisp disc-shaped Indian snack food usually made from seasoned batter of peeled black gram flour (urd flour), lentils, chickpeas, rice, tapioca or potato, fried or cooked with dry heat. Papads can be supplemented for protein with mushroom either in the form of paste or dried powder in the batter prepared from other sources as mentioned above. This can make papad a wholesome food with high protein content.

f) Mushroom sauce or ketch-up : Freshly harvested button mushrooms are washed, sliced and cooked in 50% of water for 20 minutes. Mushroom paste is prepared using a mixer grinder. Then salt (10%), sugar (25%), acetic acid (1.5%), sodium benzoate (0.065%), onion (10%), garlic (0.5%), ginger (3%), cumin (1 %), black pepper (0.1%), red chilli powder (1 5) and arrarote (0.2%) are mixed in the paste and cooked to bring its TSS to 35 °Brix. Then the ketch-up is filled in the sterilized bottles or jars.

g) Mushroom preserve (Murabba) : For preparing mushroom preserve, fresh button mushrooms are graded, washed, pricked and blanched in 0.05% KMS solution for 10 min. Blanched mushroom is

then dipped in 50 ºBrix sugar solution and refrigerated overnight. Next day mushroom is strained out of sugar solution and the solution is added with 0.1% citric acid and sufficient sugar to attain strength of 60 ºBrix by heating. Mushrooms are then dipped into it and kept overnight. This process is repeated to raise the concentration of syrup to 70 ºBrix and mushrooms are dipped into it for 1 week to prepare preserve. The preserve is then drained out of sugar syrup and filled in a container with freshly prepared sugar syrup of 68 ºBrix. The containers are then sealed airtight and stored.

h) **Mushroom candy :** The process for making candy is practically the same as that employed in the case of mushroom preserve, with the difference that the produce is impregnated with a higher concentration of sugar (75ºBrix) and is also partially dried under shade to attain the chewable consistency. The mushroom candy can be stored up to 8 months with excellent acceptability.

i) **Mushroom chips :** For preparing mushroom chips, freshly harvested button mushrooms are washed, sliced (2 mm) and blanched in 2% brine solution. The mushrooms are dipped overnight in a solution of 0.1% of citric acid + 1.5% of NaCl + 0.3% of red chilli powder. After draining off the solution, the mushrooms are subjected to drying in cabinet dryer at 60°C for 8 h. Then it is fried in the refined oil and good quality chips are prepared. After spices mixing, the chips are packed in polypropylene packets and sealed after proper labeling.

j) **Mushroom Jam :** Development of mushroom jam would aid in preserving mushrooms for a year as a product that is nutritious as well as widely acceptable. For preparation of mushroom jam, washed and blanched mushrooms are ground into a paste. This mushroom paste is then added with sugar (1:1 to paste), pectin (1% of pulp) and citric acid (1% of pulp) and heated with continuous stirring to avoid sticking to pan till it reaches a TSS of 68°Brix. This prepared jam is hot filled in sterilized glass bottles leaving a head space of 0.8 to 1.0 cm. The bottles are then sealed and stored in a cool and dry place.

Novel value added products of mushrooms

a) **Mushroom fortified corn extrudates**: Fortification levels of mushroom in extrudates were optimized for sensory and nutritional properties to a level of 20% paste and 10% mushroom powder for both single and twin screw extruders.

b) **Ready to cook frozen mushroom tikki** : Ready to cook (3 min fry) frozen mushroom tikki was developed and cohesive binding properties of mushroom shreds was optimized by using response surface methodology and taking shred size, corn starch concentration and parfrying time as the variables.

c) **Mushroom fortified cakes:** Mushroom fortified cakes have been developed and fortification to a level of 20% (as wheat flour replacement) has been found to be optimum according to sensory and textural properties of both cake and batter prior to baking.

d) **Mushroom Based Vegetarian Sausages:** Vegetarian sausages can be prepared from fresh mushroom by adding 5% saturated fat and binding agents such as carrageenan, soya protein concentrate, casein or xanthan gum.

e) **Mushroom fortified instant noodles:** Ready to cook instant noodles fortified with graded levels of mushroom (*Pleurotus ostreatus*) powder have been developed and on the basis of their nutritional and sensory properties, the level of fortification of mushroom powder @ 4 % to noodle dough was optimized.

Mushroom corn extrudates

Mushroom fortified cake

Mushroom Based Vegetarian Sausages

Mushroom fortified instant noodles

Annexure 2

Some Haryana Growers awarded by ICAR-DMR Solan

Directorate of Mushroom Research, Solan has been identifying progressive and innovative growers from all over the country and awarding them during Kisan Mela held every year on 10 Sept, the day Solan was declared Mushroom City of India. The Haryana mushroom growers awarded during last decade is as below:

Year	Name and Address
2006	Mr. Sunil Kumar, R/o Village Ahir Majra, Sonipat (Haryana)
2006	Mr. Joginder Singh, Village Saharmalpur, Panipat (Haryana)
2007	Sardar Harpal Singh, R/o Bhour -Sainda, Distt. Kurukshetra (Haryana)
2007	Smt. Asha Kiran, Asha Hi-Tech Spawn Lab, 78, Sector-2, Industrial Area, Kurukshetra, Near Pipli
2009	Mr. Harjeet Singh, Nagpal Mushroom Farm, Village Rai Majra, Shahbad (M), Distt. Kurukshetra
2009	Mr. Bijender Dhankad, Village Khubroo, Ganaur, Distt. Sonipat, Haryana
2010	Sh. Rajbeer, Village Badhana, Distt Sonipat Haryana
2010	Sh. Jagdev Singh, Amar Mushroom Farm, Village Badhana, Distt Sonipat, Haryana
2011	Shri Sunil Mallik S/o Sh. Ranbir Singh, R/o Village Shershan, District Sonipat (Haryana) 402012
2012	Jai Singh S/o Sh. Mehar Singh, Rohtak, Haryana
2013	Sh. Jitender Malik, Village : Seank, Distt. Panipat, Haryana
2013	Mr. Sandip S/o Ch. Satbir Singh, Village – Siswala, Hisar, Haryana
2014	Sh. Kanwal Singh Chauhan*, Vill.-Aterna District- Sonipat Haryana – 131 023
2015	Pardeep Kaushik S/o Shri Bhim Sain, Village Garhi Keshri, P.O. Ganaur, Teh. Ganaur Distt. Sonipat
2015	Shri Surender Hooda, S/o Sh. Bani Singh, Village Baiyanpur, Dist Sonipat (Haryana)
2015	Anil Kumar Saini S/o Sh. Murli Manohar Saini, Village Matarshyam, Distt. Hisar (Haryana)
2016	Pardeep Kaushik S/o Bhim Sain Village Garhi Keshri, P.O. Ganaur Teh. Ganaur Distt. Sonipat
2017	Mann Singh Rana,Village Samlehri, Billpura Road, Ambala Cantt
2018	2018 Smt Seema Gulati, Elle Mushrooms, Gharonda, Distt Karnal, Haryana

* Indian Council of Agricultural Research bestowed NG Ranga Farmer Award in 2010 to Sh Kanwal Singh Chauhan for diversification in Agriculture

"Mushroom growing isn't just a rapidly expanding agribusiness; it's also a significant tool for the restoration, replenishment and remediation of earth's overburdened ecosphere"

Annexure 3

Mushroom Trainings by KVKs of Haryana

There are 18 KVKs in Haryana of which KVK Ambala and Rewari are with a NGOs, KVK Karnal is with NDRI, Karnal, KVK Gurgaon is with IARI, New Delhi and rest are with CCS HAU Hisar. These KVKs have been organising trainings on mushrooms and farmers were also exposed to mushroom activity during Exposure visits, Farmer days, during trainings on crop residue management, food preservation, vocational trainings, etc. There were 50 specific trainings/activities on mushrooms in 14 KVKs some of which held in last two years (April 2016- July 2018) are listed here. There were no mushroom specific trainings in KVKs Sonipat, Karnal, Faridabad and Mahendergarh during this period.

KVK Kurukshetra	From	To
Vocational training on White Button Mushroom Cultivation	09-04-2016	09-07-2016
Vocational training on Mushroom Production Technology	11-07-2016	11-11-2016
Training on Scientific cultivation of mushroom	04-01-2017	04-05-2017
Scientific Mushroom Cultivation	09-04-2017	09-07-2017
Vocational Training on Mushroom Production Technology	11-20-2017	11-24-2017
Vocational training on Mushroom Production Technology	11-30-2017	12-04-2017
Value addition of mushroom	01-19-2018	01-19-2018
Mushroom Day	01-20-2018	01-20-2018
Vocational training on Mushroom Cultivation	02-09-2018	02-13-2018
Mushroom Field Day	02-15-2018	02-15-2018
Mushroom cultivation; straw utilization and management	07-12-2018	07-12-2018
KVK Rohtak		
Training on economics & marketing of mushroom	10-18-2016	10-18-2016
Lecture on Mushroom production technology	12-08-2016	12-08-2016
Training on Value addition of mushroom	01-04-2017	01-04-2017
Training on Drying & incorporation of green leafy vegetables and mushroom	02-03-2017	02-03-2017
Vocational training on Mushroom production Technology	10-09-2017	10-13-2017
Training on economics & marketing of mushroom	10-18-2017	10-18-2017
Training on Mushroom Production	12-19-2017	12-23-2017
Value addition of mushroom	01-06-2018	01-06-2018
KVK Yamunanagar		
Mushroom Production Technology	02-05-2016	02-09-2016
Mushroom Production	08-30-2016	09-02-2016
Cultivation of low cost mushroom	10-05-2016	10-05-2016
Cultivation of Mushroom	08-02-2017	08-02-2017
Mushroom production technology	09-26-2017	09-29-2017
Mushroom Production Technologies	12-28-2017	01-01-2018
KVK Ambala		
Training : Mushroom Cultivation Technology	07-14-2016	07-20-2016
Training : Mushroom cultivation for Self-employment	09-14-2016	09-17-2016
On Farm Trial : To Assess the acceptability of Mushroom products	12-21-2016	03-31-2017
Front Line Demonstration : Value added products of Mushroom	04-26-2017	07-31-2017
Training : Mushroom Production & Management	09-12-2017	09-15-2017

KVK Gurgaon	
Vocational Training on Mushroom Production Technology	10-25-2017 to 10-17-2017
Training on Production Technology of Mushroom under ARYA Project	03-20-2018 to 03-26-2018
Training on Beekeeping, Mushroom & Kitchen Gardening under	06-07-2018 to 06-07-2018
Training on Beekeeping, Mushroom & Kitchen Gardening under	06-18-2018 to 06-18-2018
Three days residential training on Mushroom production, Beekeeping and Kitchen Gardening under Krishi Kalyan Abhiyan	07-24-2018 to 07-26-2018
KVK Rewari	
Mushroom Production Technology	10-25-2016 to 10-27-2016
Mushroom production technology	10-27-2017 to 10-27-2017
Management of mushroom unit.	12-07-2017 to 12-07-2017
KVK Fatehabad	
Oyster and milky mushroom	08-09-2016 to 08-12-2016
Oyster mushroom	09-03-2016 to 09-03-2016
Vocational Training on Mushroom Cultivation	09-05-2016 to 09-09-2016
KVK Jhajjar	
Vocational training on mushroom production technology	09-04-2017 to 09-08-2016
Mushroom Production Technology	09-06-2018 to 09-11-2018
KVK Jind	
Vocational Training on Mushroom Cultivation for SC/ST candidates	11-04-2016 to 11-08-2016
Mushroom cultivation	01-02-2017 to 01-06-2017
KVK Panipat	
Training on Mushroom Production	11-14-2017 to 11-18-2017
KVK Kaithal	
SC/ST Vocational Training	12-03-2016 to 12-07-2016
KVK Hisar	
Mushroom Production	07-29-2016 to 07-28-2016
KVK Bhiwani	
Mushroom production technology	08-08-2016 to 08-12-2016
KVK Sirsa	
Mushroom Production Technology	12-03-2017 to 12-06-2017

Source: kvk.icar.gov.in (Trainings by 5 KGKs of CCS HAU upgraded as KVKs not included in the list above)

Annexure-4

Some commercial mushroom production units in Haryana

	District	Name and Address of commercial unit	Mushrooms produced per year (Ton)*
1.	Ambala	Madhav Fresh Foods, Ambala	450
2.	Ambala	Kiran agro	200
3.	Ambala	M/s Neeraj Kumar s/o Singram	20
4.	Bhiwani	M/s Aver Farms Rajesh s/o Sh. Ishwar	20
5.	Gurugram	Devi Lal Mushroom farm	300
6.	Gurugram	M/s Yogesh Kumar s/o Sh. Devi Ram	48
7.	Gurugram	M/s Umang Garg s/o sh. Mukesh Garg	48
8.	Gurugram	M/s Devi Lal s/o Dharam Singh	20
9.	Hisar	Sh. Chanchal Saini s/o Murli Manohar	20
10.	Hisar	M/s Dinesh Kumar s/o Sh. Net Ram	20
11.	Hisar	Sh. Bala ji Mushroom compost unit and growing unit	20
12.	Hisar	Sh. Dariya Singh s/o Nathu Ram	20
13.	Hisar	M/s Jaibir Mushroom Growing Unit	20
14.	Hisar	Krishan Mehta S/o Sh. Bansi Dhar	20
15.	Hisar	M/s Shri Balaji Mushroom Farm	20
16.	Hisar	M/s Fageria mUshroomfarm	20
17.	Jind	Chaudhary Mushroom Farm	460
18.	jind	M/s Choudhary Mushroom Farm	20
19.	Jind	M/s Dumarkha Mushroom growing unit	20
20.	Jind	M/s AAR ANN Mushroom products	20
21.	Jind	M/s Shree Krishna Mushroom Farm	20
22.	Jind	M/s Sanjeev Mushroom Farm	20
23.	Jind	Prop. Sh. Rajbir s/o Sh. Mane Ram	20
24.	Jind	Prop. Sh. Satish Kumar s/o Sh. Mane Ram	20
25.	Jind	Prop. Sh. Pardeep s/o Sh. Ram Niwas	20
26.	Jind	Smt. Geeta w/o Sh. Vijay Sharma	20
27.	Karnal	Arora Mushroom Farm, Karnal	175
28.	Karnal	ELLE Mushroom	150
29.	Karnal	M/s Maha Luxmi Mushroom Farm	20
30.	Karnal	Malkhan Singh s/o Sh. Om Parkash	32
31.	Karnal	Mrs. Kailash Devi w/o Sh. Kushal Chand	32
32.	Kurukshetra	Bajwa mushroom Farm	50
33.	Kurukshetra	M/s Rajesh MushroomFarm	20
34.	Kurukshetra	M/s CS Mushroom Farm	20
35.	Kurukshetra	M/s Radhawa Mushroom Farm	20
36.	Kurukshetra	M/s Sidheshwar Export	20
37.	Mewat	Sh. Mukut Bihari s/o Sh. Amar	20
38.	Mewat	M/s Funguys Food Inc.	20
39.	Narnaul	Bhupinder Singh	32
40.	Palwal	M/s Wolverine Farms	150
41.	Palwal	JD Agrotech-RDF Agro	50

42.	PanchKula	Aanchal Agro Mushroom Farm	64
43.	Panchkula	M/s Dharamvir Agro farm	100
44.	Panchkula	Sh. Ashok Kumar s/o Mouji Ram	48
45.	Panchkula	Sh. Kuldeep s/o Satbir	80
46.	Panchkula	Sh. Balwan s/o Chander Singh	80
47.	Panchkula	M/s Satkar Agro Mushroom Sh. Inder Singh s/o Sh. Mansa Ram	64
48.	PanchKula	M/s Bhinvar Mushroom Farm	80
49.	Panchkula	M/s Om Agro foods	48
50.	Panchkula	M/s Navjot Mushroom Farm	64
51.	Panchkula	Sh. Hemant Kumar s/o Sh. Surrender Sharma	96
52.	Panipat	Samta Agro, Panipat	60
53.	Panipat	M/s Minhas International Smt. Anil Kumar	20
54.	Panipat	M/s Rathi Mushroom Farm	20
55.	Panipat	Sh. Shyam singh s/o Khila Ram	20
56.	Rohtak	Jai Singh Saini Mushroom Farm	20
57.	Rohtak	Col. Dabas	20
58.	Sonipat	Divin Mushroom Farm, Kharkhoda, Sonipat	220
59.	Sonipat	Rajesh Mushroom Farm, Khewra, Sonipat	40
60.	Sonipat	Cap N Stem Mushroom farm, Khewra, Sonipat	120
61.	Sonipat	Surya Mushroom Farm	600
62.	Sonipat	Kartar Mushroom Farm	20
63.	Sonipat	M/s Adidev mushroom Farm	200
64.	Sonipat	M/s Sandhu Farm	20
65.	Yamunanagar	Snow Farm Fresh	1500
66.	Yamunanagar	M/s Kamboj Mushroom Farm	20
67.	Yamunanagar	M/s Radouri Mushroom farm	20
68.	Yamunanagar	M/s Organic Mushroom Sarabjot Singh s/o sh. Lakhvir S	20
69.	Yamunanagar	Sh. Pawan Kumar saini s/o Banarsi Dass	20
	TOTAL		6501

*Where ever production data was not available, the production has been taken as 20 ton/year as a standard room of 20' x 60' x 12.5' with five crops and 18% BE will produce over 20 ton mushroom in a year.

Annexure 5

MIDH (NHM) Funding and State Plan Schemes

In the last decade MIDH has provided subsidy to 95 growers for setting up one or more component of mushroom unit. The list of beneficiaries is as below:

	Year	Sub Component Mushroom	Address
1	2009-10	Mushroom production	M/s Maha Luxmi Mushroom Farm Sh. Rattan Singh, Indari, Karnal
2	2009-10	Mushroom Spawn unit	Aanchal Agro Mushroom Farm, Morni, PanchKula
3	2010-11	Integrated Mushroom Unit	M/s Kamboj Mushroom Farm, Alahar, Yamunanagar
4	2010-11	Integrated Mushroom Unit	Usha Devi w/o Partap Singh, Bhiwani
5	2010-11	Spawn making unit	Ishan Hightech spawn lab, Krishna Colony, Yamunanagar
6	2010-11	compost making unit	Jai Singh s/o Mehar Singh, Rohtak
7	2011-12	compost and spawn unit	Prabhu kripa Agro foods, Kainthal, Kurukshetra
8	2011-12	compost making unit	Pawan Mushroom compost farm, Hansi, Hisar
9	2011-12	Integrated Mushroom Unit	M/s Nisha Rani Agro Mushroom Farm, Kalka, Panchkula
10	2012-13	Integrated Mushroom Unit	M/s Bajwa Mushroom, Kurukshetra
11	2012-13	Integrated Mushroom Unit	M/s Raja Mushroom Farm, Ambala
12	2012-13	Compost Making unit	M/s Sandhu Mushroom Farm, Mustafabad, Yamunanagar
13	2012-13	Compost Making unit	M/s Jawala Ji Mushroom farm, Mustafabad, Yamunanagar
14	2012-13	Mushroom Spawn unit	M/s Ashok Kumar s/o Mukhtyar Singh, Ganaur, Sonipat
15	2012-13	compost making unit	Sushil Kumar S/o Sh. Ajmer Singh, Indri, Karnal
16	2012-13	compost making unit	Satish Kumar S/o Birbal Singh, Asand, Karnal
17	2013-14	Integrated Mushroom Unit	Divine Mushroom Farm, Kharkhoda, Sonipat
18	2013-14	Mushroom Spawn Unit	Sh. Pragat Singh (Mushroom spawn unit), Nising, Karnal
19	2013-14	Integrated Mushroom Spawn Unit	Sh. Chanchal Saini s/o Murli Manohar (Integrated Mushroom Spawn Unit), Adampur, Hisar
20	2013-14	Mushroom unit	-, Ram Saran Majra, Kurukshetra
21	2014-15	Mushroom Production unit	Kartar Singh s/o Munsi Ram, vill. Sishana, Sonipat
22	2014-15	Mushroom compost unit	M/s Baag mushroom farm, Dhanoura, Ambala
23	2014-15	Mushroom Production unit	M/s Dinesh Kumar s/o Sh. Net Ram, Adampur, Hisar
24	2014-15	Integrated Mushroom unit	M/s Seema Gulati d/o Sunder Lal Madan, Gharunda, Karnal
25	2014-15	Integrated Mushroom unit	Krishi vigyan kedar, Shikkon, Gurugram
26	2014-15	Mushroom compost unit	M/s Sartaj Mushroom, Badoni, Kurukshetra
27	2015-16	Mushroom production and compost making unit	M/s Dharamvir Agro farm, Raipur rani, Panchkula
28	2015-16	Mushroom production and compost making unit	M/s Bhupender singh s/o Jee Sukhram, Satnali, Narnual
29	2015-16	Mushroom Production unit	M/s Radouri Mushroom farm, Radouri, Yamunanagar
30	2015-16	Mushroom compost unit	M/s Harphal Mushroom farm, sadhora, Yamunanagar
31	2015-16	Mushroom production and compost making unit	Sh. Bala ji Mushroom compost unit and growing unit, Siswala, Hisar
32	2015-16	Mushroom production and compost making unit	M/s Bajwa Mushroom, Pehowa, Kurukshetra

33	2015-16	Mushroom compost unit	M/s Raja Mushroom Farm, Ambala
34	2015-16	Mushroom Production unit	M/s Neeraj Kumar s/o Singram, Narayangarh, Ambala
35	2015-16	Mushroom Production unit	M/s Minhas International Smt. Anil Kumar, Madlauda, Panipat
36	2015-16	Mushroom production and compost making unit	M/s Elle Mushroom Smt. Seema Gulati d/o Sh. Sunder Lal, Gharunda, Karnal
37	2015-16	Mushroom production and compost making unit	Malkhan Singh s/o Sh. Om Parkash, Indari, Karnal
38	2015-16	Mushroom production and compost making unit	M/s Organic Mushroom Sarabjot Singh s/o sh. Lakhvir Singh, Model town, Yamunagar
39	2015-16	Mushroom production unit and compost making unit	Sh. Pawan Kumar saini s/o Banarsi Dass, vill. Dadupur Saini, Yamunanagar
40	2015-16	Mushroom Production unit	Mrs. Kailash Devi w/o Sh. Kushal Chand, Raison, Karnal
41	2015-16	Mushroom production unit and compost making unit	Sh. Dariya Singh s/o Nathu Ram, Franshi, Hisar
42	2015-16	compost making unit	M/s Rathee Compost unit Sh. Balbir & Sh. Krishna s/o Sh. Hariya, RajluGarhi, Sonipat
43	2015-16	Integrated Mushroom Unit	M/s Asha Mushroom Farm Dinesh s/o Sh. Abhey Ram, Atterrna, Sonipat
44	2015-16	Integrated Mushroom unit	Sh. Ashok Kumar s/o Mouji Ram, Baldwala, Panchkula
45	2015-16	Mushroom production unit and compost making unit	Sh. Kuldeep s/o Satbir, Baldwala, Panchkula
46	2015-16	Mushroom production unit and compost making unit	Sh. Balwan s/o Chander Singh, Baldwala, Panchkula
47	2016-17	Mushroom Production unit	M/s Maharishi vashist Sh. Ashok Kumar s/o Shiv Om, Igrah, Jind
48	2016-17	Mushroom production unit and compost making unit	M/s Satkar Agro Mushroom Sh. Inder Singh s/o Sh. Mansa Ram, Raipur rani, Panchkula
49	2016-17	Mushroom production unit and compost making unit	M/s Rajesh Mushrrom Farm, Khewra, Sonipat
50	2016-17	Mushroom production unit and compost making unit	M/s Om Agro foods, Raipur rani, Panchkula
51	2016-17	compost making unit	Atul Arora s/o M.L. Arora, Kunjpura, Karnal
52	2016-17	Mushroom production unit and compost making unit	M/s Bhinvar Mushroom Farm, Morni, PanchKula
53	2016-17	Mushroom production unit and compost making unit	M/s Navjot Mushroom Farm, Raipur Rani, Panchkula
54	2016-17	Mushroom production unit and compost making unit	M/s Choudhary Mushroom Farm, Kandela, Jind
55	2016-17	compost making unit	M/s Mahalaxmi Mushroom Farm, Hamidpur, Kurukshetra
56	2016-17	production unit	M/s Dumarkha Mushroom growing unit, Narwana, Jind
57	2016-17	Mushroom Production unit	M/s Arora Mushroom Production unit, Kunjpura, Karnal
58	2016-17	Muishroom Spawn Unit	M/s Madhav Fresh foods, Saha, Ambala

59	2016-17	Mushroom production unit and compost making unit	M/s AAR ANN Mushroom products, Narwana, Jind
60	2016-17	Integrated Mushroom unit	M/s Rathi Mushroom Farm, Samalakha, Panipat
61	2016-17	compost making unit	M/s Joginder Mushroom Farm, Samalakha, Panipat
62	2017-18	Mushroom & compost unit	M/s CS Mushroom Farm, Pehowa, Kurukshetra
63	2017-18	Integrated Mushroom unit	M/s Shree Krishna Mushroom Farm, Pillu khera, Jind
64	2017-18	Mushroom Production Unit	M/s Sanjeev Mushroom Farm, Julana, Jind
65	2017-18	Mushroom Production Unit	M/s Yogesh Kumar s/o Sh. Devi Ram, Sohana, Gurugram
66	2017-18	Mushroom Production Unit	M/s Umang Garg s/o sh. Mukesh Garg, Sohana, Gurugram
67	2017-18	Mushroom Production Unit	M/s Devi Lal s/o Dharam Singh, Sohana, Gurugram
68	2017-18	Spawn making unit	M/s Om Agro foods, Raipur rani, Panchkula
69	2017-18	Intregated Mushroom unit	Sh. Bhoop singh s/o Sh. Lekh Ram, Badra, Bhiwani
70	2017-18	Mushroom Production Unit	Sh. Shyam singh s/o Khila Ram, Samalakha, Panipat
71	2017-18	Mushroom Production Unit	M/s Shree Ram Mushroom Farm, Bapoli, Panipat
72	2017-18	Mushroom Production Unit	M/s Prakritik Mushroom Farm, Bapoli, Panipat
73	2017-18	Mushroom Production Unit	Smt. Neha Choudhary, Kunjpura, Karnal
74	2017-18	Mushroom Production Unit and compost making unit	Sh. Hemant Kumar s/o Sh. Surinder Sharma, Kalka, Panchkula
75	2017-18	Mushroom Production Unit	Sh. Bhana Ram S/o Sh. Bhagirath, Shekhpur, Narnaul
76	2017-18	Spawn making unit	M/s C S Mushroom Farm, Bakhali, Kurukshetra
77	2017-18	Mushroom compost unit	M/s Arya Mushroom Farm, Ismailabad, Kurukshetra
78	2017-18	Mushroom Production Unit and compost making unit	Prop. Sh. Rajbir s/o Sh. Mane Ram, Kadela, Jind
79	2017-18	Mushroom Production Unit and compost making unit	Prop. Sh. Satish Kumar s/o Sh. Mane Ram, Kadela, Jind
80	2017-18	Mushroom Production Unit and compost making unit	Prop. Sh. Pardeep s/o Sh. Ram Niwas, Bhishanpura, Jind
81	2018-19	Mushroom Production Unit	M/s Jaibir Mushroom Growing Unit,
82	2018-19	Mushroom Compost Unit (Tunnel)	Neha Choudhary w/o Sh. Satpal Choudhary, Kunjpura, Karnal
83	2018-19	Mushroom Production Unit	Sunil Singh S/o Sh. Babir Singh, Gharunda, Karnal
84	2018-19	Mushroom Production Unit	Krishan Mehta S/o Sh. Bansi Dhar, Agroha, Hisar
85	2018-19	Mushroom Production Unit	Sajjan Choudhary S/o Sh. Satpal Choudhary, Kunjpura, Karnal
86	2018-19	Mushroom Compost Making unit	M/s Aver Farms, Ramesh s/o sh. Ishwar, Malwas (Kohar), Bhiwani
87	2018-19	Mushroom Production Unit	M/s Aver Farms Rajesh s/o Sh. Ishwar, Malwas (Kohar), Bhiwani
88	2018-19	Mushroom production Compost Making unit	M/s Radhawa Mushroom Farm, Kurukshetra
89	2018-19	Mushroom Production Unit	Sh. Mukut Bihari s/o Sh. Amar, Tauru, Mewat
90	2018-19	Mushroom Compost Making unit	Sh. Mukut Bihari s/o Sh. Amar, Tauru, Mewat
91	2018-19	Mushroom Compost Making	M/s Kang Mushroom Farm, Thanesar, Krurukshetra

92	2018-19	Mushroom Compost Making unit	M/s J.K. Mushroom Farm, Pehowa, Kurukshetra
93	2018-19	Mushroom Production Unit	Smt. Geeta w/o Sh. Vijay Sharma, Jind
94	2018-19	Mushroom Production Unit	M/s Funguys Food Inc., Tauru, Mewat
95	2018-19	Mushroom Production Unit	M/s Sidheshwar Export, Pehowa, Kurukshetra

State Plan Schemes

Targets and achievements during 2017-18 under different state plan schemes implemented by Department of Horticulture, Haryana are as below:

SCSP and RKVY Scheme 2017-18

Districts	Dist wise report of IHD plan scheme for SC families for 2017-18				Dist wise report of RKVY scheme for 2017-18			
	Mushroom trays (max subsidy @ 90% of total cost of Rs 300, i.e., Rs 270 per tray limited to 100 trays/beni)				**Promotion of mushroom cultivation Mushroom trays @ 50% subsidy, i.e. Rs 110/tray max 100 trays/benf.**			
	Target		Achievement		Target		Achievement	
	Phy (No)	Fin (Rs)	Phy (No.)	Fin (Rs)	Phy (No)	Fin (Rs)	Phy (No.)	Fin (Rs)
Ambala	1023	276210	1023	276210	6500	715000	6500	715000
Bhiwani	1400	378000	1400	378000	2500	275000	2500	275000
Faridabad	2000	540000	2000	540000	1000	110000	1000	110000
Palwal	2000	540000	2000	540000	0	0	0	0
Fatehabad	1000	270000	1000	270000	1000	110000	1000	110000
Gurgaon	2000	540000	2000	540000	1000	110000	900	99000
Mewat	1000	270000	1000	270000	1300	143000	1300	143000
Hisar	2000	540000	2000	540000	1000	110000	1000	110000
Y/Nagar	2000	540000	2000	540000	6000	660000	6000	660000
Jhajjar	2600	702000	2600	702000	600	66000	600	66000
Jind	2000	540000	2000	540000	900	99000	900	99000
K/Keshtra	6831	1844370	6931	1871370	1636	179960	1636	179960
Karnal	8000	2160000	8000	2160000	6000	660000	6000	660000
Kaithal	2000	540000	2000	540000	1000	110000	1000	110000
Narnaul	2000	540000	2000	540000	1000	110000	1000	110000
Panchkula	2000	540000	2000	540000	1600	176000	1600	176000
Panipat	10444	2819880	10444	2819880	5600	616000	5600	616000
Rohtak	2000	540000	2000	540000	1000	110000	1000	110000
Rewari	2000	540000	2000	540000	1000	110000	1000	110000
Sonipat	10000	2700000	10000	2700000	6000	660000	6000	660000
Sirsa	2000	540000	2000	540000	700	77000	700	77000
C. Dadri	2000	540000	2000	540000				
G. Total	68298	18440460	68398	18467460	47336	5206960	47236	5195960
Actual		18440500		18325953				5195473

IHD for Shivalik Area

Promotion of Horticulture in Shivalik area (Panchkula, Ambala, Yamunanagar) IHD 2017-18

	Component :		Mushroom shed	
Unit cost (in Rs) : 50000	Rate of Asss (Rs) : 75%			
			Amount of assistance:	37500
	Target		Achievement	
Dist	Phy (No)	Fin (Rs)	Phy (No.)	Fin (Rs)
Panchkula	10	375000	17	195000
Ambala	14	525000	17	637500
Yamunanagar	20	750000	17	637500
G. Total	44	1650000	51	1470000

Support from National Horticulture Board (NHB)

The growers intending to take higher subsidy approach NHB. There have been only five growers that have availed subsidy from the NHB that is only 7.5% of the projects sanctioned by NHB.

Year	Total mushroom projects given subsidy by NHB	Number of beneficiaries from Haryana	Firms/farmers who got subsidy
2011-12	12	0	-
2012-13	7	0	-
2013-14	13	3	Ankur Gupta, 314, Kiran Villa, Mahesh Nagar, Ambala Cantt. (Haryana) Integrated Unit For Mushroom Development, Village & Tehsil-Aterna, Distt.-Sonipat, (Haryana) Vivek Gupta, C/o Gupta Nursing Home, Raipur Rani, Panchkula (Haryana)- 134204
2014-15	11	1	Farm Fresh Foods, village Talheri, Vill Peohwa, Distt Kurukshetra (Haryana)
2015-16	17	1	A S Agro Mushroom White button mushroom Farm Rani Park, Ambala Cant (Haryana)
2016-17	7	0	-
Total	67	5	
Percent	100	7.5	

Source : nhb.gov.in

Annexure 6

Proposed Performa for Registration for Spawn Laboratories in Haryana State

A	**Profile of the Firm**	
1	Name of the Spawn Lab	
2	Whether Registered (please attach certificate of incorporation)	
3	Name of The Owner/Scientist Incharge	
4	TIN/TAN of Unit (please attach photocopy)	
5	PAN of Unit/Owner) (Please attach photocopy)	
6	Name of Bank with Account No./IFSC Code	
7	Address of Unit (Please attach documentary proof of land allotment/revenue record)	
8	Correspondence address	
9	Landline No.	
10	Fax No.	
11	Mobile No.	
12	Email address	
13	Website address, if any	
14	Year of Establishment	
15	Annual Turn Over	
16	Whether any assistance availed	
17	Amount of assistance	
18	Source of assistance	
19	Date of Assistance	

B.	**Details of the Infrastructure**	
a)	**Total area of Unit (Square meter)**	
1	Office Room	
2	Store Room	
3	Boiler Room	
4	Mixture/Bag-bottle filling Room	
5	Autoclave Room	
6	Inoculation Room	
7	Incubation Room	
8	Cold Storage Room	
9	Wash Room	
10	Workers Room	
11	Sales Room	
12	Transport Vehicle	
b)	**Instruments available**	
1	Laminar Flow	

	a	Size of one Laminar flow	
	b	No. of Laminar flow	
2		BOD Incubator (No.)	
3		Fridge (No.)	
4		Air Conditioner (Capacity in tons)	
5		Generator (Capacity)	
6		Autoclave	
	a	No. of Autoclaves	
	b	Type of Autoclaves	
	c	Total capacity of all Autoclaves	
7		pH Meter	
		Other instruments	
		1) Air Curtains	
		2) Ozone Generator	
		3) Oven	
		4) Weighing Balance	
		5) UV Tubes (Nos.)	
		6) Any other, pl. specify	
8		Data loggers	
9		Display boards	
10		Packing & tagging facilities	
C		**Other Information**	
1		Technical Experts	
		Name	
		1	
		2	
		3	
		Other Workers	
2		Good Manufacturing Practices	
		1. Lab Coat	
		2. Foot Wears	
		3. Gloves	
		4. Caps	
		5. First Aid Box	
		6. Fire Safety Equipments	
3		Raw Materials	
		1. Agar-agar	
		2. Glucose	
		3. Calcium sulphate	
		4. Calcium Carbonate	
		5. Malt Extract/PDA	
		6. Any other chemical	
		7. Grains	

	a. Wheat	
	b. Bajra	
	c. Any Other	
	8. Poly Propylene Bags	
	9. Alcohol/Spirit	
	10. Glass-wares	
	11. Non-absorbent cotton	
	12. PP Rings/Microbial Filter Bags	
	13. Butter Papers/Tissue Papers	
	14. LPG Cylinder/Burners	

D	**Detail of Cultures & Spawn**	
a)	Information on Strains	
1.	Button Mushroom	
	a. Source of Culture/Strains	
	b. Name of Culture/Strains	
	c. Date of Purchase	
2.	Oyster Mushroom	
	a. Source of Culture/Strains	
	b. Name of Culture/Strains	
	c. Date of Purchase	
3.	Milky Mushroom	
	a. Source of Culture/Strains	
	b. Name of Culture/Strains	
	c. Date of P Purchase	
4.	Paddy-straw Mushroom	
	a. Source of Culture/Strains	
	b. Name of Culture/Strains	
	c. Date of Purchase	
5.	Shitake/Any other Mushroom	
	a. Source of Culture/Strains	
	b. Name of Culture/Strains	
	c. Date of Purchase	
6.	Standard format for record-keeping for Culture & Spawn multiplication, maintained	
7.	Standard format of label available	
b.	Spawn Production	
1	Installed capacity per annum (qtls.)	
2	Total Spawn produced (qtls)	
3	Whether Spawn so produced tested or not.	
c.	Any other information one wish to share	

Certified that the above information is true to the best of my knowledge and belief and nothing has been concealed there in.

Date:- Name & Signature of unit holder with Stamp

E	**Inspection Team Report**	
1	The information provided in the Performa is available or not	
	If no, the information no. which is lacking.	
2	Status of hygienic conditions	
3	Quality of Spawn on visual assessment	
4	Whether spawn is free from contaminants	
5	Rating	Tick appropriate
	5 Star	
	4 Star	
	3 Star	
	2 Star	
	1 Star	
	Not recommended	
	Recommendation:	

(Member 1) Name:_____ Signatures_____
(Member 2) Name:_____ Signatures_____
(Member 3) Name:_____ Signatures_____
(Member 4) Name:_____ Signatures_____
(Member 5) Name:_____ Signatures_____

Annexure 7

Some Machinery suppliers in India

During interaction with consumers or while searching the information from other sources including internet, we came across various companies that may be relevant to mushroom growers. The alphabetical list given below is only **indicative and not any recommendation**.

Autoclave

- Grover enterprises, New Delhi (https://www.indiacom.com/delhi/grover-enterprises_delhi_dli_57953.html)
- Machin Fabrik, Navi Mumbai (http://www.machinfabrik.com/steam_sterilizers.html)
- Narang Scientific works, Delhi (http://www.nsw-india.com/)
- Nat Steel Equipment Pvt. Ltd., Mumbai (http://nat-steel.com/)
- Pharmalab India Pvt Limited, Mumbai (https://www.pharmalab.com/steam-sterilizer/)
- Yorco sales pvt Ltd, New Delhi (http://yorco.com/)

Laminar Flow

- ACMAS technocracy pvt Ltd Delhi
- Grover enterprises, New Delhi (https://www.indiacom.com/delhi/grover-enterprises_delhi_dli_57953.html)
- Indo scientific & surgicals (www.indoscientific.com/)
- Indosaw, Osaw Industrial products, Ambala (www.indosawagri.com/)
- Klenzaids Engineers Pvt Ltd, Mumbai (http://www.pharmatechnologyindex.com/profile/klenzaids-engineers-pvt-ltd)
- Narang Scientific works, Delhi (http://www.nsw-india.com/)
- Yorco sales pvt Ltd, New Delhi (http://yorco.com/)

Centrifugal fans, AHU, cooling systems

- Advance Ventilation Pvt. Ltd. Chaudhary Blowers, Kundli (http://www.advanceventilation.com/)
- Aerotech, Noida (www.aeppl.com) (New name TERAL Airotech)
- Caryaire Equipmennts India Pvt Ltd, Noida (www.caryaire.com) (http://www.caryaireequipments.com/)
- VTS (http://vtsgroup.in/VENTUS.html)
- Zeco, New Delhi (http://www.zecoaircon.com/)
- Nicotra India Pvt Ltd, Noida (www.nicotra.com) (AHU fans)
- Shakti Engineering works, Patiala (https://www.indiamart.com/shakti-industries-patiala/) (mainly Ammonia direct injection)
- Fedders Lloyd, New Delhi (https://www.indiamart.com/proddetail/tower-air-conditioner-2883923730.html)

Cooling/cold room

- Airef engineers, New Delhi (http://www.airefengineers.com/)
- Batliboi & company (http://www.batliboi.com/)
- Bitzer, Daryaganj, New Delhi (https://www.bitzer.de/us/us/bitzer-worldwide/country-detail_97094.jsp) (Mainly compressor)

- BLUE STAR (https://www.bluestarindia.com/)
- Bluecold Refrigeration (www.bluecoldref.com)
- Carycore Refrigeration India Pvt. Ltd. Greater Noida (www.carycore.com) (starcore.co.in/products.php)
- Daikin India (https://www.daikinindia.com/products-services/chillers)
- Delta systems (http://www.deltacoolingtowers.in/)
- EMICON (http://www.emiconindia.com/)
- Fedders Lloyd, New Delhi (https://www.indiamart.com/proddetail/tower-air-conditioner-2883923730.html)
- Frick India Ltd (compressors) delhi@frick.co.in
- Indo scientific & surgicals (www.indoscientific.com/)
- Kirloskar Compressor (www.kirloskarkpcl.com/)
- S.M refrigeration Pvt Ltd (https://www.justdial.com/Delhi/S-M-Refrigeration-Pvt-Ltd-Near-Ganga-Ram-Hosipital-Old-Rajender-Nagar/011P90404_BZDET)
- Shakti Engineering works, Patiala (https://www.indiamart.com/shakti-industries-patiala/)
- Temp Master Enterprises, New Delhi (http://www.temp-masters.com/)
- Universal Industries, New Delhi (https://www.indiamart.com/universal-industries-delhi/profile.html)

Boilers

- Cheema Boilers Limited, Mohali, Punjab (http://cheemaboilers.com/)
- Indcon Boilers, New Delhi (http://indconboilers.net/)
- Lal Sons & Company, A-45, Ph -1, Mayapuri New Delhi (011 2514 3230)
- Laxmi Boilers (North), 602, Deepali, 92, Nehru Place, New Delhi - 110 019.
- MSI Industrial Fans &b Blowers, New Delhi (www.msifans.com)
- Thermax Ltd, New Delhi (https://www.thermaxglobal.com/)
- Urjex Industries, Meerut (http://www.urjexboilers.com/)

Canning

- Bajaj Process pack Ltd Noida (http://www.bajajmachines.com/)
- Goodwill Industries, New Delhi (goodwilldelhi@gmail.com)
- M/s B. Sen Barry & Co, New Delhi (http://www.bsenbarry.com/)
- M/s. Cowel Can Ltd.Industrial Area, Barotiwala, Distt. Solan, (H.P.) (www.dcmsme.gov.in/publications/pmryprof/food/ch2.pdf),
- M/s. Divecha Glass Industries249, Bal Rajeshwar Road,Office L.B.S. Marg, Mulund (W),Mumbai-400080
- Mariental India (http://marientalindia.com/)
- Nu-Tech Dairy Engineers Pvt. Ltd. Saha, Ambala www.nutechdairyengineers.com/
- Rollatainers (https://www.rollatainers.in/)

Compost machinery

- Agri Masters Industry, Mohali (https://www.indiamart.com/agrimasterindia/aboutus.html)
- Nu-Tech Dairy Engineers Pvt. Ltd. Saha, Ambala www.nutechdairyengineers.com/
- JCB India Ltd, Ballabgarh, Haryana (www.jcb.com)

Filters

- AAF India Pvt Ltd, UPSIDC Site A, Surajpur, Habibpur, Uttar Pradesh 20130
- Green Environment Technology, New Delhi (www.get-india.in/)
- Thermodyne Pvt Ltd, Faridabad (Haryana), (www.thermodyne.co.in)

PUF panels

- Kingspan Jindal Pvt Ltd Nalagarh (HP) (http://jindalmectec.com/)
- Sintex Plastics Technology Ltd. Kalol (Gujarat) (http://www.sintexplastics.com/)
- Synergy Thrislington, Nalagarh (www. Synergythrislington.com)

Miscellanious

- A S polymers india, 451-Jeet Singh Market, Jolly Road, Kukra, Muzaffarnagar UP(Silicone and wrapping film)
- Advance Tech India Pvt Ltd (www.atechindia.com), Mohali (automation, sensors)
- Decibel Dynamics 312, Industrial area, Phase-1 Chandigarh –160002 (digital thermometers)
- M/S Chopra Plastic, New Delhi (https://www.indiamart.com/chopra-plastics/) (PP rings, 4" spigots, etc)
- MCCOY & DOW corning (Non acidic silicon for sealing PUF panels)
- Swan Environmental Pvt Ltd, Hyderabad (www.swn-she.com) (Dragger tube for Ammonia)
- Unique thermopack for punnets (Punnets)
- VAM Industries, Chandigarh (www.vamindustries.com) (Punnets)
- Welkin Overseas Roorkee (Spigots for 6” PVC pipe)

There are many small manufacturers dealing with blowers, fabrication of AHU, cooling systems, ducting, etc. It may be ensured that the items are as per specifications and give the desired output. While placing order for centrifugal fan for tunnel, it is important to tell the manufacturer that temperature of air will be 60 °C, humidity of air can be above 95% and ammonia in the air can be over 250 ppm.

A workshop near Lalru making compost machinery (Punjab)

Visit to Canning line, bunker filler manufacturing unit in Saha (Ambala)

Annexure 8

Some Machinery suppliers outside India

Given below is alphabetical list some of the international companies dealing with mushroom equipment and related areas. For details you may visit their websites and also search for more by interaction with end users or through net/other sources.

No	Firm & Website	Deals with
1.	AEM BV., Netherlands (www.aembv.com)	Automation, Indoor compost systems, Climate computers, Ventilation systems, Computer control & Project Designing
2.	AIR SYSTEM SUB, Italy (www.airfung.it)	Tunnel building, Installations/climate control, Climate computers
3.	Allcold Refrigeration, China (www.allcoldtec.com)	Modified atmosphere packaging, vacuum coolig, tube ice machine, etc
4.	ALPI OFFICINE-SIGNORESSA DI TREVIGNANO, Italy (www.officinealpi.com)	Casing machines, Bunker filling machines, Compost equipment, Headfilling machine
5.	AMMERAAL BELTECH BV, Netherlands (www.ammeraalbeltech.nl)	Conveyor belts
6.	AMYCEL BV, Netherlands (www.amycel.eu)	Supplements, Spawn
7.	Anhui Kanle Machinery Technology Co., Ltd, China (www.akanle.com)	Equipment for automated assembly lines for speciality mushrooms
8.	ARCO, Netherlands (www.arco-solutions.nl)	Automation, Bunkers, Harvesting machine, Mushroom processing
9.	B & D Baldor, China. (baldor-tech.com)	Screw air compressors
10.	BANKS MUSHROOMS / SCELTA MUSHROOMS, Netherlands (www.bankenchampignons.com)	Mushroom processing
11.	BEST Lianyungang Best Mechanical Equipment Co., Ltd, China (www.chabst.com)	Complete set of equipments for assembly line for speciality mushrooms
12.	BONAR, Belgium (www.bonar.com)	Growing room nets, tunnel nets
13.	Bulusi, China (www.zjbulusi.com)	Air conditioning equipments
14.	BVB Substrates - EURO VEEN BV, Netherlands (www.bvb-substrates.nl)	Advice, Bunkers, Casing soil
15.	CHAMP FOOD INTERNATIONAL, Netherlands (www.champfood.com)	Mushroom supplements, Dosing hopper
16.	CHAMPION, Poland (champion@championgroup.eu)	Project designing & machines for growing
17.	CHRISTIAENS GROUP, Netherlands (www.christiaensgroup.com)	Tunnel building, Bunkers, Bunker filling machines, Mushroom farms, Turnkey projects
18.	CNC COMMODITIES BV, Netherlands (www.cnc.nl)	Compost, Casing soil
19.	CNC Exotic Mushrooms BV, Netherlands (www.cncexoticmushrooms.com)	Substrate for shiitake, Substrate for exotic mushrooms
20.	Coenegrachts Substraat, Belgium (coenegrachts-Substraat.be)	Mushroom substrate
21.	Dachang, China (www.dgdachang.com)	PUF panels, modular solutions
22.	Dalsem MUSHROOM PROJECTS BV, Netherlands (www.dalsemmushroom.nl)	Bunkers, Mushroom growing rooms, Air handling systems, Project development

23.	Delphy, Netherlands (www.delphy.nl)	Advice, Project development, Training
24.	DIDAK INJECTION SA, Belgium (www.didak.be)	Packaging
25.	DOFRA, Netherlands (www.ftnondofra.com)	Mushrooms processing lines, Watering systems, Shelves
26.	DUTCH MUSHROOM EQUIPMENT BV, Netherlands (www.dme-online.nl)	Casing machines, Harvesting machines/systems
27.	DUTCHTECSOURCE BV, Netherlands (www.dutchtecsource.com)	Harvesting machines, Mushrooms processing lines, IQF operations, slices, dices
28.	E-NEMA, Germany (www.e-nema.de)	Plant protection biological (sciarid larvae)
29.	EURO INDUSTRY SP. Z OO, Poland (www.headfilling.com)	Dosing hopper, Mechanical filling and emptying, Ruffling-levelling machines
30.	EUROMYCEL, France (www.euromycel.com)	Spawn
31.	EUROSUBSTRAT SA, France (www.eurosubstrat.com)	King Oyster, Oyster (Grey, Yellow, Pink), *Pholioto*, Shiitake, ready to fruit bags
32.	FANCOM, Netherlands (www.fancommushroom.com)	Automation, Computers/computer technology, Climate systems
33.	FLORAGARD VERTRIEBS GMBH, Germany (www.floragard.de)	Casing soil
34.	FOOD TECHNOLOGY NORTH EAST NETHERLANDS BV, Netherlands (www.ftnon.com)	Harvesting machine, Portabella slicer, Conveyor belts
35.	FTNON, Netherlands (www.ftnon.com)	Watering systems, harvesting equipment, aluminium shelving
36.	Fujian Zhangzhou Mushroom Service Centre, China. (www.fjsyj.com)	Rings, necks, misc
37.	FUNGISEM, Spain (www.fungisem.es)	Spawn and substrates
38.	Fuzhou Jingxiang Automation Technology Co., Ltd, China (www.fzjxauto.com)	Automation
39.	GICOM BV, Netherlands (www.gicom.nl)	Advice, Automation, Air-handling systems, Tunnel Building
40.	GLOBAL ROEL MEDIA, Netherlands (www.mushroombusiness.com)	Media (Mushroom business Journal)
41.	GTL EUROPE ENGINEERING BV, Netherlands (www.gtl-europe.nl)	Tunnel building, Bunkers, Bunker filling machines
42.	Gourmet Mushroom Inc (www.mycopia.com)	Automated bottle production equipment
43.	Guxing Mechanics, China (www.gx-jx.com)	Automated bagging line equipments - speciality mushrooms
44.	HARTE PEAT LTD, Ireland (www.hartepeat.com)	Casing soil
45.	HATO BV, Netherlands (www.hato.lighting)	Electric Installations
46.	HOLLANDER SPAWN BV, Netherlands (www.hollanderspawn.com)	Spawn
47.	HOLLARTS PLASTIC GROUP BV, Netherlands (www.hollarts.nl)	Packaging
48.	Holpol-SUB, Poland (www.holpol.pl)	Compost, Full-grown compost, Headfilling machine

49.	HOOYMANS COMPOST BV, Netherlands (www.hooymanscompost.nl)	Full-grown compost
50.	HOVING HOLLAND INT. BV, Netherlands (www.hoving-holland.nl, www.hovingholand.com)	Bunker filling machines, Composting equipment, Spawning machines, Indoor compost systems
51.	Huali Group Co., Ltd, China (www.hualichina.cn)	Condensing Units, Air conditioning systeems
52.	HUESKER SYNTHETIC BV, Netherlands (www.huesker.nl)	Tunnel nets
53.	ITALSPAWN, Italy (www.italspawn.com)	Spawn
54.	JF MCKENNA LTD, Ireland (www.jfmckenna.com)	Mushroom farms, Climate computers, Watering systems
55.	Kai Teng Gong Ye, China (zry1001@163.c0m)	Projects, Automated conveyer, bottling etc for speciality mushrooms
56.	Keheng Environmental China (www.jskeheng.com)	Speciality mushrooms
57.	KMACH, China (www.kmachgroup.com)	Phase I, bunker fillers, growing rooms, shelving, nets and various other machines
58.	KOLKMAN PACKAGING BV, Netherlands (www.kvh.nl)	Packaging
59.	KUSTERS BV, Netherlands (www.pgkusters.nl)	Foil, Plant protection biological, Plant protection chemical
60.	Lambert Spawn Co. Inc, USA (https://www.lambertspawn.com)	spawn
61.	LAMBERT SPAWN EUROPE BV, Netherlands (www.lambertspawn.eu)	Spawn, Cultivation counselling
62.	Le Lion, USA (email: mrd@kennett.net)	spawn
63.	Lentin de la Buche, France (lentindelabuche.henry@wanadoo.fr)	Speciality mushroom substrates/ ready to fruit bags
64.	Lianyungang Guoxin Mushroom complete equipment Co. Ltd, China (www.lygguoxin.com)	Exotic mushroom bag system & bottle system equipment suppliers, filters, V-shape Solid Fermentation System
65.	Limbraco BV, Netherlands (www.limbraco.nl)	Advice, Automation, Climate systems, Turnkey projects
66.	LTO SEASONAL WORK, Netherlands (www.seizoensarbeid.nl)	Staff counselling
67.	LTO, Netherlands (www.lto.nl)	Advice
68.	LUCKY GROUP SP. Z OO, Poland (www.luckygrower.com)	Aluminium, Supplements, Blanching systems, Air ducts,
69.	MC DON PEAT SUPPLIES LTD, Ireland (www.mcdon-mushroomcasing.co.uk)	Casing Soil
70.	MERTENS, Netherlands (www.mertens-mushrooms.com)	Advice, Chlorine dosating devices, Plant protection biological, Plant protection chemical, foil, air filtering, flexible air distribution hoses
71.	MUSH COMB BV, Netherlands (www.mushroommachinery.com)	Bunker filling machines, Spawning machines, Head filling machines, Turkey projects
72.	MUSHROOM OFFICE, Netherlands (www.mushroomoffice.com)	Advice, Training, Cultivation counselling

73.	MYCELIA, Belgium (www.mycelia.be)	Advice, Spawn, King Oyster, *Pholiota*
74.	Nanjing League Storage Equipment Co., Ltd, China (www.njlige.com)	Mushroom shelves for speciality mushrooms
75.	NEDFLEX, Netherlands (www.nedflex.nl)	Staff counselling
76.	NUTRILITE GAIN LTD, United Kingdom (www.nutrigain.com)	Mushroom feeders, Supplements, Casing Supplement
77.	NV Coenegrachts substrate, Belgium (www.coenegrachts-substraat.be)	Full-grown compost, Spawned compost
78.	OMORI EUROPE BV, Netherlands (www.omorieurope.com)	Packaging machine
79.	Panbo Systems BV, Netherlands (www.panbo.nl)	Advice, Tunnel building, Mushroom farms, Air conditioning systems
80.	Penn State, Mushroom Spawn Lab (mushroomspawn.cas.psu.edu/)	Cultures, Spawn
81.	Pilzhof Wallhausen, Netherlands (www.pilzhof-wallhausen.de)	Full-grown compost, Spawned compost, Cultivation counselling
82.	Pilzzucht Hesse, Germany (pilzzuchthesse@aol.com)	Speciality mushroom substrates/ ready to fruit bags
83.	Qiyuan, China (www.boyeqiyuang.com)	Bag filling and other machines for specialityy mushrooms
84.	R & H Ruihong Metal, China (www.mushroomshelvesb2b.com)	Standard growing shelving, floor drain, wind fairing, watering tree, growing nets, etc
85.	RUBCOAT BV, Netherlands (www.rubcoat.com)	Cel and tunnel coating, Tunnel building, Mushroom farms
86.	Segae Precision Co. Ltd (https://sgp.m.ec21,com	Automatic mushroom cultivation line/plan
87.	SGP www.SGPKorea.com	Automatic mushroom cultivation line
88.	SAC02, Belgium (www.saco2.com)	Stainless steel machine building, Breathable bags
89.	Scatoplus, Australia (www.scatoplus.com.au)	Compost, Peat, Mushrooms, advice
90.	SCELTA MUSHROOMS / BANKS CHAMPIGNONS, Netherlands (www.sceltamushrooms.com)	Mushroom processing
91.	SCHUITEMAKER MACHINES BV, Netherlands (www.sr-schuitemaker.nl)	Bunker filling machines, Composting equipment
92.	Shandong KMTECH Automation Equipment Co Ltd., China (www.adkmtech.com)	Mushroom cultivation systems, Design drawings, equipmennt for button mushroom
93.	Shenzhen Hechengxing Lighting Technology Co., Ltd, China (www.hcxgd.com)	LED for mushroom houses
94.	Shenzhen Tiding Industrial Co., Ltd, China (sztiding.com)	Humidifying machines
95.	Shijiazhuang Xinghe Storehouse Equipment Co Ltd, China (www.hebxh.com)	Store house equipments, speciality mushrooms
96.	Sterckx Mushroom substrate, Belgium (www.sterckx.com)	Mushroom substtrate
97.	SYLVAN NETHERLANDS BV, Netherlands (www.sylvaninc.com)	Advice, Supplements, Filtering fibre, Cultivation counselling
98.	Substraatbedrijf Horst, The Netherlands (www. substraatbedrijfhorst.nl)	Speciality mushroom substrates/ ready to fruit bags

99.	Tai Zhou Shi Lu Qiao Jing Lei Shai Wang Chang, China. (ztzjlswc.1688.com)	Mushroom nets
100.	TENCATE, Netherlands (www.tencate.com)	Friction-reduction nets, Growing room nets, Tunnel nets
101.	THE MUSEUM LOCHT, Netherlands (www.delocht.nl)	Museum asparagus, Mushrooms,
102.	Three Public environmental, China (www.ttszll.com.cn, www.zgszhb.com)	Mushroom fabrics, filters, etc
103.	TOPTERRA HOLLAND BV, Netherlands (www.topterra.com)	Ready made Casing soil
104.	UNICORN IMP AND MFG CORP, United States (www.unicornbags.com)	Automation, Filterbags, Foil
105.	VAN BOXTEL ELEKTRO BV-UDEN, Netherlands (www.vbv.nl)	Automation, Mushroom processing lines, Harvesting machines/systems, Fans
106.	VAN DEN TOP MACHINEBOUW BV, Netherlands (www.topmachinebouw.nl)	Automation, Mushroom processing lines, Casing soil machinery, Harvesting machine
107.	VENEMA INSTALLATIONS BV, Netherlands (www.venema.installations.com)	Mushroom processing lines, Packaging, Full automatic lid machine,
108.	VERSTAPPEN PACKAGING, Netherlands (www.verstappenverpakkingen.nl)	Packaging
109.	VISCON FRESH PRODUCE, Netherlands (www.visconfreshproduce.com)	Automation, Harvesting machine, Mushroom processing lines, Machines for cultivation/harvest
110.	Vullings SYSTEMS BV, Netherlands (www.vullings-horst.nl)	Automation, Chlorine dosating devices, Watering systems
111.	WALKRO Blitterswijck BV, Netherlands (www.walkro.eu)	Spawned compost, Cultivation counselling
112.	WANDA Hongkong biological technology group Co. Ltd (www.wandagy.com)	One stop service for edible fungi industry, mainly speciality mushrooms
113.	WEBER COOLING, Netherlands (www.webercooling.com)	Cold store
114.	Yehua Machinery, China. (www.yehuajixie.com)	Machines speciality mushroom
115.	Yichang metal mesh co. Ltd, China (www.ycfence.com)	Shelving, speciality mushrooms
116.	Zhangzhou Xingbao Machinery Co., Ltd. Fujian Machinery Science Research Institute, China (www.zzxbjx.com)	Mixing, bag filling and other machines for automation in speciality mushrooms
117.	ZHEJIANG HONGYE EQUIPMENT TECHNOLOGY, China (www.gtmhy.com)	Casing machines, Bunker filling machines, Mushroom growing rooms, Watering systems
118.	ZHEJIANG KINGFIT Environment CO LTD (GTM), China (www.kingfit.com.cn)	Mushroom growing rooms, CO_2- control equipment, Climate systems, Air filters, AHUs
119.	Zhengzhou Dechengxin Humidifying Equipment Co. Ltd, China (www.gerunjiashi.com)	Humidifying, watering equipments
120.	ZIJLSTRA METAALBEWERKING BV, KLAAS - BERLTSUM, Netherlands (www.klaas-zijlstra.nl)	Construction
121.	ZLTO, Netherlands (www.zlto.nl)	Advice

On line Training Courses on Mushroom Production

Become a Mushroom Growing Expert

There are many different institutes across the world that impart online training. Two (i) ACS distance education and (ii) 'has' are listed here.

ACS in its 100 hour course, focuses on the most widely cultivated mushroom (i.e. *Agaricus*). If your interests are wider than this, all is not lost. This course does provide a valuable introduction to a much wider range of mushrooms; and can be used as a starting point for growing any of these as well. The school has excellent and rare resources relating to growing a wide range of edible fungi; and can help set students on the right course for growing species beyond just *Agaricus*.

Hogeschool (has) University offers online course, The e-learning course Mushrooms consists of 8 modules. You must first pass the test at the end of each module, before you can continue with the next module.

During the course you are able to put in your actually cultivation process by photos, graphs and figures. Together with the course teacher the cultivation will be analyzed for future improvements. At the end of the course you will have a clear view how to grow mushrooms, which processes are important for good results in yield and quality. You are able to determine, measuring and improving your cultivation outcomes and performance indicators.

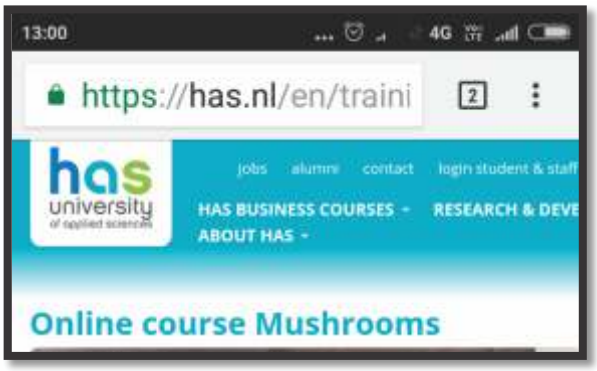
Some other online courses are:

https://delphy.nl/en/training/online-course-mushrooms-spoc/

https://www.careerlinecourses.com.au/horticulture/mushroom-production-online-course/

https://www.kickstarter.com/projects/mycologos/mycologos-the-worlds-first-mycology-school

http://www.acs.edu.au/courses/Mushroom-Production-86.aspx



https://has.nl/en/training/online-course-mushrooms

Certificate In Mushroom Production | Uttarakhand Open University archive.uou.ac.in/programme/cmp10

http://www.gardendesignacademy.com/distancemushrooms.html

One Year Courses: The National Institute of Open Schooling (NIOS)

https://nios.ac.in/departmentsunits/vocational-education/one-year-courses.aspx

A note on enhancing Vit D in mushrooms

To add value to the products, vitamin D can be enhanced by exposing mushrooms to UV light. As a marketing strategy the fact that mushrooms are the only vegetable containing Vit D can be highlighted

Detailed note on vit D enhancement is as below:

Scenario

1. With the changing life style, particularly in urban areas, Vit D deficiency is on increase
2. No vegetable except mushrooms is a source of Vit D.
3. The mushroom growing in the wild are good source of Vit D whereas those grown inside rooms have lower concentration as these are grown in dark.
4. Exposure of cultivated mushrooms to UV light for 15 minutes after harvest has been shown to increase vit D content by about 100 times. There are scientific reports where UV light has been used during cultivation and vit D content increase up to 600 times has been reported. (It may be added that UV light is part of sunlight spectrum.)

Scope

It may be possible to develop Vit D enhanced mushrooms by exposing mushrooms to UV light soon after harvest to a level where one serving a day may be adequate enough to meet minimum need of vit D of human beings.

What needs to be done?

a) Produce vit D enhanced mushrooms

We need to standardize the time and extent of exposure to UV light and get the mushrooms samples analysed for Vit D_2 content in unexposed mushrooms, in mushrooms exposed for 5 & 15 minutes, and in mushrooms after blanching and canning.

UV tube has limited life and is costly. Many years ago I worked on a low cost UV lamp. Hence, it may be possible to develop a low cost system for the above. As exposure to UV light can be harmful to us, a detailed protocol may be developed that may involve:

-how to make low cost UV lamps,

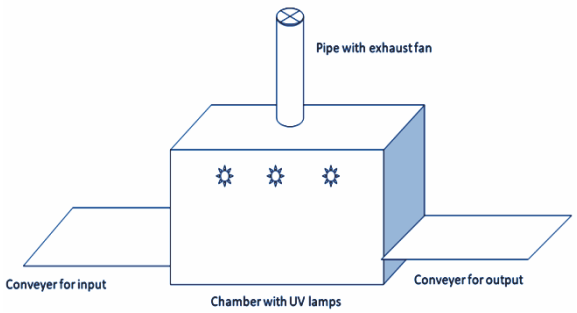
-use of glass shields,

-technical details of exposure time and other precautions.

The technology can be sold as such or even installed at farmers' units. Different agencies like PBTI, Mohali, NABI, Mohali can help to certify Vit D enhancement that may promote sale of such mushrooms.

The size of the unit for UV treatment will depend upon time of exposure and the efficiency of workers to fill the punnets or the production capacity of the unit. The unit should be separate from packing unit. After packing the trays may be shifted to this unit by conveyer belts. The unit may be fitted with a pipe on top having exhaust fan. This will ensure that ozone produced during the UV exposure does not affect the workers. After 15 minutes, the trays will move to next room through conveyer where film and label can be put on the punnets.

An alternative approach is to use pulsed UV radiaiton for few seconds. This will also ensure that there is no loss of colour or quality of mushrooms and in addition will also sterilize te mushrooms at surface. UV light is also reported to be highly effective in enhancing Vit D in dried or freeze dried samples.



b) Pickles as a by product

During grading and after blanching 10-20 % mushrooms are discarded due to oversize, breakage or opening of veil, etc. Such mushrooms and others undersize, open and others left after grading and not suitable for canning can be utilized for making pickles.

Here also Vit D enhanced mushrooms can be used to add value to the product. Further, vit D is oil soluble compound and hence the pickle can also be fortified with additional amount of vit D to make it a supplement wherein small quantity of pickle can also meet the needs of vit D.

Marketing strategy

These days majority of the working class suffers from Vit D deficiency. It can be specified that the product contains vit D enhanced mushrooms and mushrooms are the only vegetable having Vit D occurring naturally. Even though there are number of other benefits like high fibre, source of Vit B_{12}, minerals like copper and selenium, etc but it may be better to focus only on one point, that is, Vit D.

Some slogans

Some slogans for display on buses or other public places (pictures of button, oyster, shiitake, etc may be added)

Grow Mushrooms, Eat Mushrooms

Mushroom- The health food

Mushrooms - Only vegetable having Vit D and B_{12}

Mushrooms are good for high blood pressure patients as these have low sodium high potassium

Mushrooms are delight of diabetics: have no starch

More money, assured production from less land

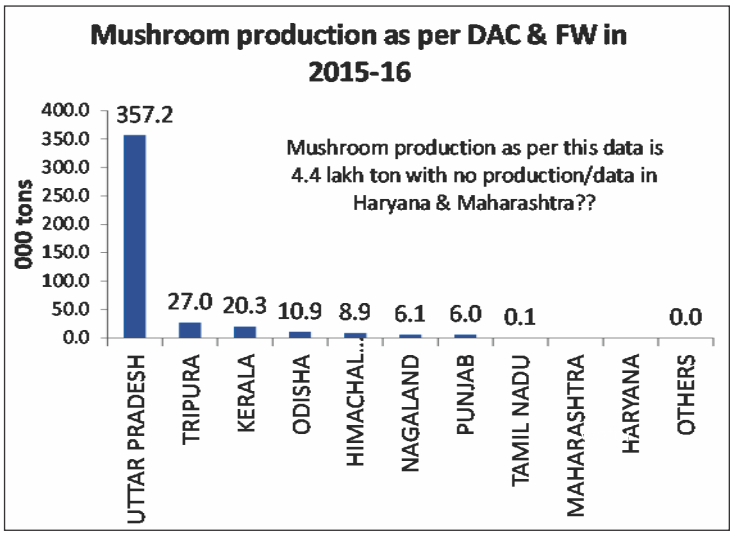
Do not burn straws, use these for growing mushrooms

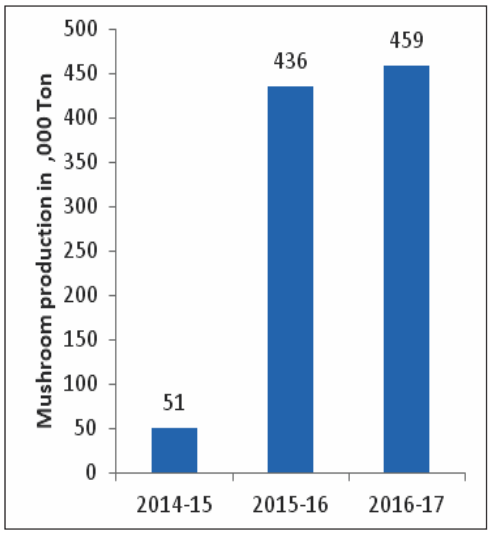
Mushrooms have quality protein: Replace meat with mushroom

Status of Data collection and Needs

Data from DAC & FW

There is vast variation in the data of mushroom production. There is hardly any data available on species-wise production. As per DAC & FW, the mushroom production in 2014-15 was 0.51 lakh, in 2015-16 it was 4.4 lakh ton and there was no production in states like Maharashtra and Haryana (which as we know are the leading states) [18]. In the recently published data book 'Horticulture at a Glance 2017' [19] by DAC & FW, the production has been reported to increase still further to 4.6 lakh ton (Figure below). In Agriculture statistics at a glance 2016, p219 [10], production of mushroom for 2015-16 is, however, mentioned as 76000 ton.

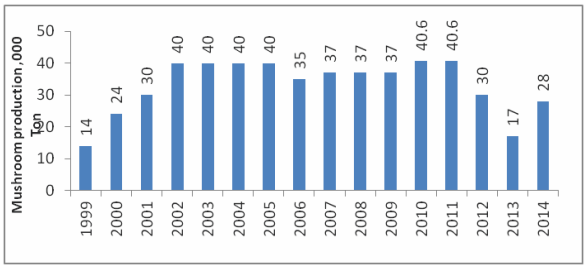




Source : http://agricoop.nic.in/statistics/state-level (Horticulture crop estimate 2016) [18]; Horticulture Statistics at a Glance 2017 (DAC & FW) www.agricoop.nic.in [19]

FAO Data

Mushroom production of India as per FAO STAT is much less than reported by DAC. It was around 40,000 ton from 2002 to 2011 and started declining thereafter.(Fig. below). The decline can be attributed to setback to Agro Dutch mushroom unit in Lalru (Punjab) that was biggest mushroom production unit in the country and at one stage was producing almost half of the button mushroom produced in the country. As per FAOSTAT, in 2014-15 mushroom production in India was 28 thousand ton [19].

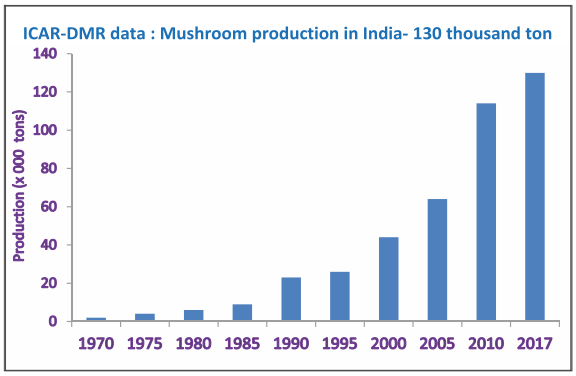


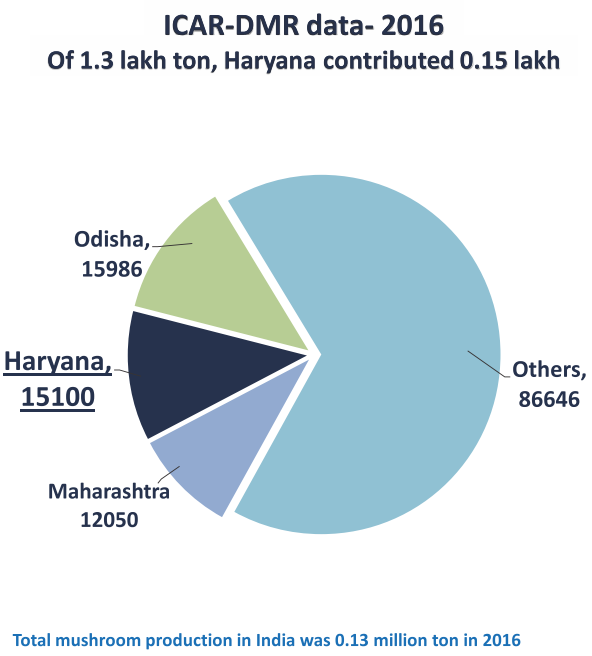
Mushroom production in India (FAO STAT) [20]

ICAR-DMR Data

DMR Solan collected data in 2011 at national level, published it in the book 'Mushroom cultivation, marketing and consumption by DMR Solan [] where in the total production of mushroom it in the country was estimated as 1.13 lakh ton and data has been revised recently and published in the Journal,

Mushroom Research, in 2017 where the production was about 130 thousand ton (production of Haryana = 15100 ton). As per latest (2018) unpublished estimate of DMR, the production of the country at present is 144 thousand ton and the growth rate is about 4.3 with Maharashtra as the number one producer in the country.

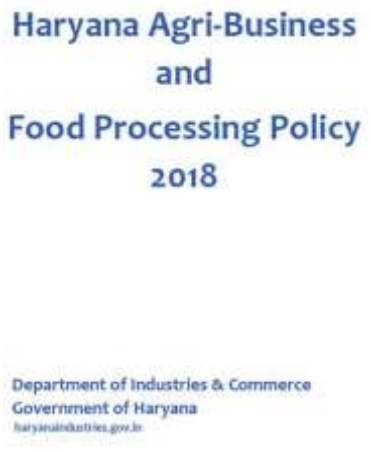




Total mushroom production in India was 0.13 million ton in 2016

Deptt. of Industries, Haryana Data

Annual mushroom production in the Haryana state in 2015-16, as reported in Haryana Agri-Business and Food Processing Policy 2018, Department of Industries & Commerce, Government of Haryana (haryanaindustries.gov.in), is **38370 million ton** (page 11) [21] which obviously is an error in data transformation as the world production of mushroom is only around 38 million ton. Here MT seems to have been taken as million ton instead of Metric Ton. Even after this benefit of doubt, the production is about four times than that of Department of Horticultuure. Thus there is vast gap in the production values by different agencies

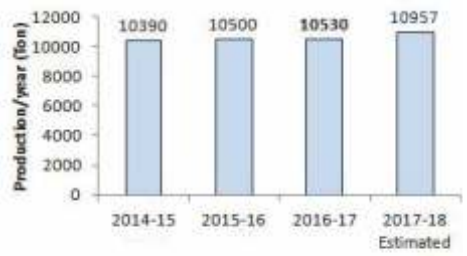


Vegetables			
Produce	Annual Production (2015-2016)	Some regions of growth	Value Added Products
Cauliflower	85082 million tons	Kurukshetra, Karnal, Panipat, Sonipat, Bhiwani, Gurugram, Faridabad	Diced Cauliflower
Onion	64351 million tons	Ambala, Jhajjar, Mewat, Bhiwani, Yamunanagar	Onion Flakes, Powder, Paste, etc.
Carrot	45396 million tons	Sonipat, Fatehabad, Hisar, Bhiwani ,Faridabad	Diced Radish
Green Peas	10156 million tons	Kurukshetra, Kaithal, Panipat, Gurugram	Fresh peas export, canned peas
Mushroom	38370 million tons	Sonipat, Kurukshetra, Yamunanagar, Panchkula	Fresh mushroom export, canned mushrooms

Data of Deptt. of Horticulture, Haryana

Mushroom production in Haryana as per Department of Horticulture was 10500 ton in 2016-17 [6]. When we tried to extrapolate the production based on the rough estimates of spawn produced in the state, the production reported by Department of Horticulture was not matching and if the information provided by the growers on spawning rate and biological efficiency and data provided informally by private spawn producers on spawn production is correct, then the production may be almost double of what has been reported by the department.

It appears that department officials focus on those who have taken subsidy under SHM and are not getting data from big producers who have not availed any subsidy or have done so from NHB.



District wise data on production and number of trays since 1990 available on website
http://hortharyana.gov.in/en/statistical-data

Production Data – a gross Mismatch

Any policy based on incomplete data will be GIGO

Source	Year	India million kg	Haryana Million kg
FAO	2014	28	?
ICAR-DMR	2016	130	15.1
DAC&FW	2016	459	0
Dept of Hort., Haryana	2016	?	10.5
Dept of Ind., Haryana	2017	?	38.4*

*Presuming MT interpreted as million ton instead of metric ton
1 million kg = 1 thousand ton

Analysis

The problems in data arise because there is no set agency to systematically collected data on minor crops including mushrooms. In the states, the departments of Horticulture collect some information through their district level functionaries. It appears that data is collected from growers which are in the list and who have availed subsidy. There are many commercial growers who do not avail any subsidy or take subsidy from other sources like NHB, APEDA, etc. It is not clear that whether all these growers are included or not. Further, the data is collected only for button mushroom.

The problem also arises as there is no standard method or representation of data. MT is interpreted as Metric Ton by some and Million ton by others. To avoid this confusion, it may be better to report data in million kg (1 million kg = one thousand ton). Haryana department of Horticulture still represents the area or compost used in terms of trays even though nowhere in the world trays are being used to cultivate button mushroom. Hence there is need for synchronisation of data and also need for species wise data collection. Documentation of all the growers in the form of data base is a prerequisite for this. Separate sheet for each species may be there with minimum questions. A questionnaire like below can be developed where grower may have to answer only few questions. The proforma can be sent to all the registered growers.

1) **Species :**
   - a) Button mushroom ☐
   - b) Oyster mushroom ☐
   - c) Milky mushroom ☐
   - d) Paddy straw mushroom ☐
   - e) Shiitake ☐
   - f) Other (please specify)

2) **Source of spawn**
   - a) Govt lab
     - i) Within state ☐
     - ii) Outside state ☐
   - b) Private
     - i) Within state ☐
     - ii) Outside state ☐

3) **Compost / substrate**
   - a) Made by self ☐
   - b) Purchased (specify the source) ☐

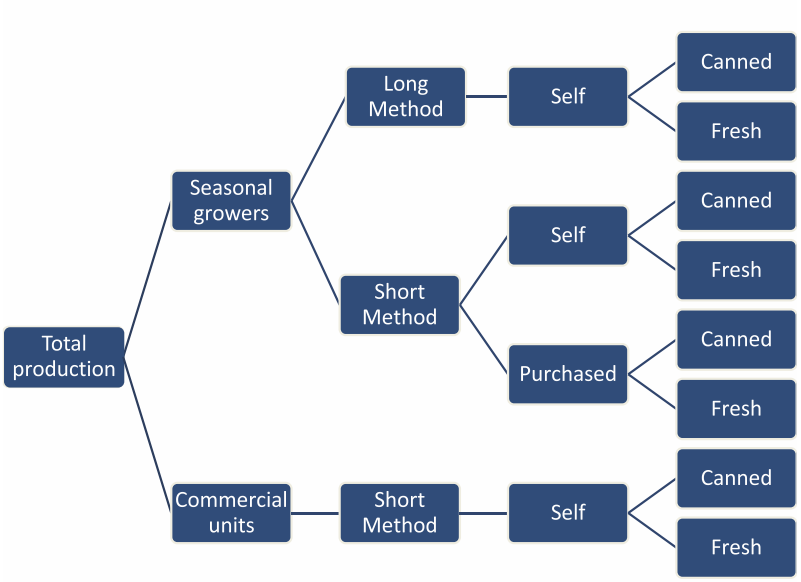
4) **Method used** for compost/substrate preparation (if made by self)
   a) Long method ☐
   b) Short method ☐
   c) Pasteurisation by hot water treatment ☐
   d) chemical pasteurisation ☐
   e) Autoclaving ☐
   f) Any other (Please specify) ☐
5) **Total mushroom output** (in ton): .....

Additional information

a) How much sold as fresh (tonnes) .....
b) How much sold to canners (tonnes).....
c) How much sold as dried or pickled or processed at home.....
d) Total investment .....
e) Total Sale.....
f) Profit.....

Data collection- a flow chart for button mushroom

We have seen that adequate data is not available. Any policy for increasing production or consumption requires validated data on different aspects. Hence data for each mushroom may be collected. For button the collection flowchart can be as given below. Similar flow charts can be developed for other mushrooms.



No policy can succeed without good science &
There cannot be any science without good data

Recommendations of National Symposium on Mushroom held at Agro R&D Centre, Murthal (31 January to 2 February 2019)

About the Symposium

HAIC Agro R&D Centre organised a National Symposium on "Trends & Innovations in Mushroom Production Technologies, Diversification, Processing and Consumption" at Integrated Mushroom R&D Project, HAIC Agro R&D Centre, Murthal (Haryana) from 31 Jan to 2 Feb 2019 in collaboration with MHU Karnal, ICAR-DMR Solan, DCRUST Murthal and NIFTEM, Kundli, Haryana. Sh Jagdish Chander, IFS, Executive Director, HAIC Agro R&D Centre, and Managing Director, Haryana Agro Ind. Corp. Ltd. was the convener and Dr. Ajay Singh, Scientist Incharge HAIC Agro R&D Centre, Murthal & Registrar, MHU, Karnal was the Organizing Secretary of the symposium. Dr Ramesh Yadava, Chairman, Haryana Kisn & Agricutural Costs & Prices Commission was the Chief Guest at inaugural function.

There were 183 participants from 19 states of the country. In total 93 abstracts were submitted for the symposium. Nine lead lecture and 26 oral papers were presented. Five best posters were awarded. In addition to presentations there was visit to HAIC Agro R&D spawn lab, compost facilities, cropping rooms, visit to NIFTEM, and visit to farmers' fields (Sh Harpal Singh Bajwa, Ms Seema Gulati) to see canning and mushroom cultivation in huts, *Cordyceps* farm, etc. The presentations were organised into six sessions viz.,

1. Spawn, compost and cultivation technologies of button mushroom (*Agaricus bisporus*)
2. Biodiversity and diversification into speciality mushrooms
3. Label claims, residue analysis, GAP for pest and disease management
4. Mushroom processing, products, product quality, safety standards and consumption
5. Economics, marketing, linkages and policy issues
6. Farmers' viewpoint and future needs

Recommendations

Recommendations based on presentations and discussion in different sessions are:

- Germplasm collection and biodiversity conservation of mushrooms needs greater attention. Details of all edible fungi collected and consumed in different regions of the country by local inhabitants may be collected and compiled along with pictures and ITK.
- For promotion of mushrooms, labs for large scale production of quality spawn of different species and also production of ready to fruit bags of different species may be developed
- Use of paddy straw may be promoted for preparation of compost, especially in North India. GAP for all mushroom species may be developed for our conditions.
- Standard designs may be developed for all mushrooms suitable for different regions of the country for seasonal and commercial cultivation. Greater emphasis may be given on mechanisation and indigenous machinery may be developed for the same.
- Use of SMS for polyhouses/pot mixture/ manure may be promoted
- Considering the contribution of HAIC in promotion of mushrooms in Haryana, facilities like HAIC Agro R&D may be replicated in each state of the Country for promotion of mushrooms
- New breeding techniques for developing mushroom hybrids have to be exploited on large scale using different markers.
- Greater focus may be given on diversification and cultivation of shiitake, king oyster, Oyster and various other tropical mushrooms. Target of utilization of 1% straw for mushroom cultivation in next five years may be set for promotion of

mushroom cultivation and recycling of agro-waste.

- NCCD, MOFPI, NHB & MIDH may provide government assistance for cultivation of shiitake, king oyster, *Cordyceps militaris* and other important mushrooms
- To address the problems of disease management there is need for greater awareness generation about pasteurisation of compost/casing (replacement of long method by short method) and cookout/sterilisation of substrate before disposal, and sterilisation of rooms before next cycle of the crop
- In view of "prevention is better than cure" we need to promote significance of strict cleanliness, maintenance of hygiene, maintenance of ideal environmental conditions in the growing rooms, safer use of chemicals/ bio-pesticides and using light traps for management of flies
- Suitable bio-pesticides/botanicals/safer chemicals should be evolved to effectively and timely manage the pests and diseases of mushrooms. Good neem-based products have been developed and found effective to manage nematode infestation in mushroom cultivation. These may be evaluated on large scale.
- Considering that there is hardly any pesticide having label claim for mushroom in India, the pesticides having label claim in USA, Europe and other developed countries should be identified and may be deemed to have label claim for use in India. Focused discussion involving all stakeholders may be organised to discuss the issue of label claims, residue limits, exposure limits.
- Considering that button mushroom growers in our country are getting less than 20 kg mushroom per 100 ckg compost as compared to 32-35 kg in developed countries, a separate brain storming session on breaking 20 kg barrier may be organized
- . Mushroom products like biscuits, mushroom powder incorporated noodles, energy bar, etc and novel/indigenous mushroom products may be developed along with detailed nutritional analysis and promoted by collaborating with industry
- Processing technologies, MAP, packaging, labelling, etc will require collaborative work and thus linkages among different organisations may be strengthened
- The health benefits of mushrooms like source of vit D, quality protein, etc may be promoted by government agencies to enhance consumption of mushrooms and mushroom products
- Processing of mushrooms for functional foods or as supplements and promote use of mushrooms as supplements and medicinal benefits of mushrooms need promotion.
- Mushroom cultivation in Haryana is the outcome of innovations by the farmers. There have been innovations by entrepreneurs like use of poly-fill and Tybek for spawn production. There is need to document and recognize farmers' innovations/ citizens science.
- Need for mechanism for state-wise and species-wise data collection on production and consumption. Studies on mushroom consumption pattern in different groups of age, sex, region, rural/urban, caste, etc may be undertaken.
- ICT: Promote e-education (online training) and e-commerce (use of social platforms)
- Formation of group of mushroom growers in the country is also the need of the grower for better marketing and creative awareness among the masses.

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About the Members of the Working Group

Dr Manjit Singh
Chairman

Dr Manjit Singh did his M.Sc (Genetics) and Ph.D (Genetics) from Punjab Agricultural University, Ludhiana and joined Agricultural Research Services (ARS) of Indian Council of Agricultural Research (ICAR) in the first batch in 1976. During his four decades of service in the Council he held various positions and retired as Director, ICAR-Directorate of Mushroom Research, Solan (HP). After retirement he served as Mushroom Advisor, Govt. of Punjab and at present is General Secretary, World Society of Mushroom Biology and Mushroom Products. He received MS Randhawa Medal, ICAR Team award, produced eight mushroom varieties and hybrids, cultivated wood ear mushroom on wheat straw, developed zero energy poly tunnel technology and published over 70 research papers and 150 other publications.

Dr VP Sharma
Member

Dr VP Sharma did his M.Sc. and Ph.D. in Mycology and Plant Pathology (Mushrooms) from Dr. YSP University of Horticulture & Forestry, Nauni. He joined the UHF, Nauni Assistant Mycologist in May, 1990, Joined ICAR-DMR, Solan as Sr. Scientist in February 2004 and is serving as the Director, ICAR-DMR, Solan since October 2015. Throughout his career he has focused on mushroom research and for his work on mushroom, he was twice awarded Yadavindra Young Scientist Award by Mushroom Society of India. Presently, he is President of Mushroom Society of India. He has been Editor/Editor-in-Chief of Indian Journal of Mushroom and Mushroom Research Journal. He has published over 110 Research Papers, five books and many bulletins.

Dr Ajay Singh
Member

Dr Ajay Singh did his B. Sc (Hons), M.Sc and Ph.D (Plant Pathology) from CCS Haryana Agricultural University, Hisar. During M.Sc and Ph.D, he worked on Cultivation, Management of Competitor Moulds and Post harvest Technology of White button Mushroom. He joined HAIC Agro R&D Centre in the year 2000 and has been Scientist Incharge of this centre for over 15 years. During this period he has made significant contributions to promote mushrooms in the state by supplying spawn, spawned compost and providing regular trainings. He has attended several International Mushroom Conferences and trainings abroad and has published over 50 papers and 7 books on mushroom production technology. He is Member, Executive Council of DCR University of Science & Technology, Murthal and is now Registrar, Maharana Pratap Horticultural University (MHU), Karnal.

Dr Surjeet Singh
Member

Dr Surjeet Singh has been professor of Plant Pathology at CCS HAU till September 2018. During his over three decades of service he worked on different aspects of mushrooms and guided students in areas of Mushroom cultivation, diseases and other related topics. He has been regularly publishing articles, organising exhibitions and disseminating mushroom cultivation technology through TV talks, radio programs, press and other popular articles.

“Mushrooms - The Health Food

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Haryana Kisan & Agricultural Costs and Prices Commission

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