IMPACT OF MUSHROOM RESEARCH and DEVELOPMENT PROGRAMMES in the NORTHERN REGION OF KERALA

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FOREWORD

This publication is the documentation of nearly fifteen years' effort in popularizing mushroom cultivation in North Kerala.

At a time when public investment in technology development and dissemination is strongly challenged, this compendium is a testimonial as to how user friendly technology when backed up by sensitive support , can be used to harness the entrepreneurial abilities of the women and unemployed youth in our societies.

While not laying any claim to having achieved anything stupendous, we hope it provides a stimulus to many others working at technology - development interface to try and come out with much more substantial contributions.

Needless to say all these have been achieved through the support rendered by the Kerala Agricultural University through its various offices at various times.

We are also thankful to the support of the University in bringing out this publication.

Padnekkad
26-12-2005

Authors

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PART I

Impact of Mushroom Research and Development Programmes in the Northern Region of Kerala

1. INTRODUCTION

Mushrooms belong to a group of organisms called fungi. They lack chlorophyll, cannot produce their own food and depend on other living or dead plants for food. The term mushroom is generally used to denote edible fleshy fungi. There are large number of mushroom species growing wild in nature. While many are edible, some are mild to deadly poisonous. People are fond of eating mushrooms from generations due to its delicate taste, palatability and nutritive value. There are about 45000 known species of fungi and about 2000 of them are considered edible. Of these, less than 25 species are widely accepted as food item and only about a dozen of them have been commercially cultivated. Mushroom is the fungal fruiting body technically called sporophore.

1.1 International Scenario in mushroom production

Owing to the growing awareness about the properties, the world market for mushroom is ever increasing and is estimated at 2.7 million tonnes per annum. The world output on the other hand is only about 2 million tones and the gap of 0.7 million tonnes augurs well for developing countries. Availability of technology, human resources, favourable climatic conditions and the low cost of production make mushroom cultivation in India a profitable venture. The cost of production in India is as little as Rs. 10 to Rs. 15 per kg as against Rs 35 per kg in developed countries.

1.2 Mushroom cultivation in India

The advances in technology has resulted in increased mushroom production in India. White button mushroom *(Agaricus bisporus)*, Oyster mushroom *(Pleurotus* spp.), and paddy straw mushroom *(Volvariella volvaceae)* are the commercially cultivated types in India. Mushroom production was started in India in sixties and increased rapidly during nineties.

During 1985, the annual production was 4000 tonnes. It has reached 38,000 tonnes in 1997 and at present it is estimated to be around 50,000 tonnes per year. (Table1)

Table 1: Mushroom production in India

Year	Quantity
1985	4000
1993	29000
1994	30000
1995	32000
1996	35000
1997	30000

India's exports are over 20,000 tonnes per annum. The growth rate in exports has been over 15 per cent per annum over the last few years

1.3. Importance of Mushroom cultivation

Mushroom is an indoor crop, grows independently of sunlight, feeds on organic matter and does not require fertile soil. In addition to floor, air space is also utilised, leading to higher productivity (Table 2). Mushrooms have delicate taste and palatability. They are a rich source of nutrients, particularly proteins, minerals and vitamins such as vitamin B, C and D. Their content of the antipellagra vitamin Niacin is comparable to its level found in pork or beef, which are the richest sources of this vitamin. They are also a good source of iron, potassium and phosphorus. They also contain folic acid, which plays an important role in the enrichment of blood serum. They contain low quantity of sodium and hence is ideal for persons with heart and kidney problems. Mushrooms contain not only higher percentage of protein than cereals and pulses but its digestibility is also comparable to them.

Table 2: Production of crude protein and gross energy by crops and animals compared with edible mushrooms

Species	Yield component	Yield (Kg/ha)	DM (%)	Yield DM(Kg/ha)	Crude protein (%)	Gross energy MJ/Kg	Crude protein Kg/ha	Gross MJ/Kg
Rice	Grain	5670	86.0	4876	7.7	18	375	87768
Grass (Perennial)	Total harvested	60000	10.0	12000	17.5	18.5	2100	222000
Potatoes	Tuber	27621	21.0	5800	9.0	13.6	52.5	102080
Wheat	Grain	4394	86	3779	12.4	18.4	469	69534
Maize	Grain	4654	86	3995	9.8	19.0	392	75905
Cattle (Dairy)	Milk			3386	3.5	2.6	118.5	8770
Pigs				875	12.0	16.5	105	14438
Hen	Eggs			624	11.9	6.6	74	4118
P.sajor caju	Total harvested	248888	10	24888	22.5	12.5	5599	312,344
P.flabellatus	Total harvested	133333	10	13333	21.6	11.3	2880	151196
Agaricus bisporus	Total harvested	189000	10	18900	26.3	13.7	4970	259308

Source: Rajarathnam. *et al.* 1992.

Certain mushrooms possess many useful medicinal attributes. Recently, variety of medicinal preparations in the form of tablets, capsules and extracts from mushrooms have been introduced in the market.

As already stated, mushrooms depend on other living or dead plants for their food. Since they utilize lignocellulose as food material for their growth through enzymatic degradation, mushroom culture is an excellent means for the recycling of nearly 25 million tonnes of

agrowastes presently available in our country. Hence cost of production of mushroom protein is much lower.

To ensure supply throughout the year and that we eat edible delicious mushroom, artificial cultivation is necessary. In India, four types of mushrooms viz., paddy straw mushroom (*Volvariella volvacea*), oyster mushroom (*Pleurotus* spp.) and European or button mushroom (*Agaricus bisporus*) and milky mushroom *(Calocybe)* are cultivated. The requirements and growth conditions for these mushrooms are presented in Table 3.

Table 3. Requirements and growth conditions of important mushrooms cultivated in India

Sl. No	Name of mushroom & common species cultivated	Crop cycle (days)	Temperature (°C)		Humidity (%)	Substrates	Bioefficiency (%)
			Spawn running	Cropping			
1	Paddy straw mushroom (*Volvariella volvacea, Volvariella diplasia*)	24	24	30-35	80-90	Paddy straw	10
2	Oyster mushroom						
a	*Pleurotus citrinopileatus* (white)	35-40	20-30	20-30	75-90	Paddy straw	40-100
b	*Pleurotus sajor-caju* (grey)	40-45	20-30	20-30	75-90	Paddy straw	40-100
3	European mushroom or Button mushroom *(Agaricus bisporus)*	90	21-23	14-15	85-95	Paddy/ wheat straw compost	30-40
4	Milky mushroom (*Calocybe*)	40-45	20-35	26-32	75-90	Paddy straw, wheat straw	30-50

The above table reveals that oyster mushroom is highly suitable for cultivation in plains and hilly areas and has more bioefficiency (40-100%) than paddy straw mushroom (10%) or European mushroom (30%). Cultivation techniques of oyster mushroom are also relatively simpler and easier to follow. Considering these factors, cultivation of oyster mushroom has become popular in Kerala.

1.4 Edible and Poisonous Mushrooms

Mushrooms generally appear during rainy seasons from June to November. They grow everywhere like gardens, open fields, decaying woods, marshy places, heaps of stored straw, farm yard manure etc.

All mushrooms are not edible. Among the public, edibility of mushroom is based more on long held beliefs/notions than on scientific facts. The fallacy of the notions are brought out by the number of mushroom poisoning every year.

The general beliefs and the reasons for not generalizing or rationalizing them are given in Table 4.

Table 4 General beliefs about wild mushrooms.

Beliefs about wild mushroom	Facts
1. Edible mushrooms peel off easily and dose not change the colour of silver spoon to black while cooking	*Amanita phalloides* (a deadly poisonous mushroom) peels off easily and silver spoon remain unaffected.
2. Brightly coloured mushrooms are poisonous, white or creamy ones are edible.	a. *Cantharellus cibarius* (chanterelle) and *Tricholoma nuduns* (wood blewits) are bright coloured, but safe to use. b. *Amanita phalloides* (death cap), *Amanita verna* (Fools mushroom) and *Amanita verosa* (Destroying angel) are white and poisonous
3. Animals will not eat poisonous mushrooms	Slugs feed on *Amanita phalloides* (death cap). Stomach contents of rabbits neutralize poisons of most dangerous mushroom species.
4. One genus mostly having edible species would not include poisonous mushrooms.	*Agaricus* includes many edible species but *A. xanthoderma* is poisonous. *Amanita* includes many poisonous species but *A.rubescense* is edible.

Different types of symptoms occur due to consumption of poisonous mushrooms.

1. Nervous disorders: Degeneration of cells of the organs particularly of the nervous system, liver etc. occur due to *Amanita phalloides.*
2. Gastric disorders : Gastric disturbances by exciting and paralyzing the central nervous system is caused by *Amanita mascara* and gastric enteritis is caused by *Gyromitra esculenta.*
3. Haemolytic disorder: *Amanita rubescense* cause haemolytic disorders by destroying blood.
4. Muscular disorders: Many poisonous fungi cause muscular pain and disorders.

In case of mushroom poisoning, a doctor may be contacted immediately and medical treatment obtained.

1.5 Mushroom flora of Kerala

Kerala is bestowed with a diversity of climatic conditions and soil types and hence an abundant wealth of mushrooms. Bhavani Devi and Nair (1991) have studied the mushroom flora of Kerala. Based on the periodicity of occurrence and their abundance, the

PREFACE

The "Impact of Mushroom Research and Development Programmes in the Northern Region of Kerala" is a documentation of the efforts to popularize mushroom production technology in North Kerala. This publication traces developments both at institutional level as well as at technology transfer level. As the results indicate, mushroom technology has been ably employed to create livelihood opportunities and empower the rural youth as well as women. This ultimately is what technology is supposed to do.

I am sure, this publication will serve as a timely reminder of the impact that sensitive use of technology can bring out. I congratulate all those who have made the above possible.

I also congratulate the scientists as well as Directorate of Extension for their initiative in bringing out this publication.

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26-12-2005

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flora can be grouped as pre monsoon flora, monsoon flora and post monsoon flora. The different species belonging to the following genera are common in the state. They are *Lepiota, Macrolepiota, Coprinus, Marasmius, Pleurotus, Termitomyces, Agaricus, Psathyrella, Cortenarius, Schizophyllum and Tricholoma.*

Different species of Agaricus occur in large numbers during the pre monsoon showers. Though most of them are edible they are not consumed by the people. Different species of *Pleurotus* occur in Kerala (Table 5). The promising species are *P.opuntiae, P.cornucopiae* and *P.ostreatus*. Though all the species of Pleurotus are of common occurrence, *Pleurotus squararrosilus* was found to be the most common species occurring in large numbers through out the state during both monsoon periods. Locally it is known as Marakoonu since they are seen growing on old stumps, logs and even on branches of living trees. *P.citrinopileatus* was found occurring in the cashew *(Anacardium occidentale)* tree trunks in large numbers while *P. sryinus* was found solitarily on the stump of a dried up camphor tree. *P. eous* was found on the stumps of *Artocarpos hirsutea* after the pre monsoon showers and *P. flabellatus* was found on an old dying ceiba cotton tree.

Table 5. Different species of *Pleurotus* reported from Kerala

Species of *Pleurotus*	Source
P. opuntiae	Oil palm bunch waste
P.cornucopiae	Fencing stumps of Jatropha
P.ostreatus	Coconut husks and old logs
P.citrinopileatus	Cashew tree trunks*(Anacardium occidentale)*
P.dryinus	Stump of dried up camphor tree *(Cinnamomum camphora)*
P.eous	Stumps of *Artocarpus hirsuta*
P.flabellatus	Old dying Ceiba cotton tree *(Ceiba pentandra)*
P.lignatilis	Logs of *Artocarpus incise*
P.luteoalbus	Base of an old mango tree *(Mangifera indica)*
P.mastrucatus	Roots of a coconut tree *(Cocos nucefera)*
P.petaloides	Decaying coconut tree stump
P.pometi	Old coconut husk waste
P.pubescens	Oil palm bunch waste
P.salignus	Oil palm bunch waste
P.serotinus	Oil palm bunch waste
P.pulmonarius	Oil palm bunch waste

Source: Bhavani Devi. S and M.C. Nair 1991.

The highly succulent and large mushroom viz. *Tricholoma georgi* also known as *Calocybe gambosa* occur during the north east pre monsoon showers. The fact that all collections were made from the basins of coconut palm indicate the mycorrhizal nature of fungus.

Termitomyces is found to be the most common edible mushroom species collected and consumed by the people of the state. Locally it is known by different names in different regions like Uppukoon, Arikoon, Mazhathandan, Perumkala, Nilampulappan etc. *Termitomyces heimii* occurs abundantly in forest areas. The periodicity of occurrence of Termitomyces is given in Table 6.

Table 6. Periodicity of occurrence and distribution of Termitomyces sps.

Sl.No	Species	Intensity	Period	Termites associated
1	*T. robustus*	+	June, July	*Odontotermes brunneus*
2	*T.heimii*	++++	September, October	*Odontotermes malabaricus*
3	*T.radicatus*	++	July	*Odontotermes obesus*
4	*T.clypeatus*	+++	July	*Odontotermes rademani*
5	*T.giobulus*	+++	July	
6	*T.striatus*	++	October	*Odontotermes* sp
7	*T.perforans*	++	June, July	
8	*T.microcarpus*	++	June, July	*Odontotermes obesus*
9	*T.microcarpus var. santalensis*	++++	September, October	*Odontotermes obesus*

++++ 50 – 100 and more sporocarps ++ 10 – 25 scattered

+++ 25 -50 and more sporocarps + 1 – 10 solitary

Source: Sreelatha Nair and Bhavani Devi 1991

During the pre monsoon summer shower period, *Boletus edulis* (Locally known as Pannikoon) was found occurring under the Jack fruit trees . Though it has an undesirable smell, people consume it adding onions while preparing the recipe.

Calvatia giganta is reported to occur in large numbers on lawns during the pre monsoon season. It is known as Muttakoon due to its resemblance with egg. People in some parts of the state collect and consume it.

1.6 Scope of mushroom cultivation in Northern Kerala

Mushroom is becoming a prominent delicacy particularly in balanced diet. With high literacy and health awareness, people of Kerala readily accept it as health food. Since the

land requirement for mushroom cultivation unlike for other crops is considerably less, small farmers of Kerala can easily adopt it. Considering the unemployment situation and lack of large-scale industries, income-generating activity like mushroom cultivation has immense scope. Climatically also, Kerala has an ideal environment for the cultivation of oyster mushroom. Moreover, Northern Kerala has high potential for cultivation of mushroom due to the potential availability of agricultural wastes.

1.7 Availability of organic wastes for mushroom production

Cellulose is the earth's most abundant renewable raw material, with about 10-15 tonnes per person being produced annually by plants. Most of the cellulose occurs in intimate association with a complex plant structural material called lignin. The resulting lignocelluloses are by far the most prevalent renewable organic material available for mushroom cultivation.

Among the raw materials commercially used, paddy straw is the substrate most readily available for *Pleurotus* cultivation in Kerala. A variety of waste materials derived from agriculture can also serve as substrates for microbial processes. Based on the available data (Farm Guide, 2005), the various agricultural by-product substitutes available in Northern Kerala (Kannur, Kasaragod, Kozhikode and Malappuram Districts) is estimated at 3.06 million tons of crop residues, comprising of paddy straw, banana pseudostem, arecanut leaf sheaths, coconut leaves etc. (Table 7). It can be assumed that 25% of the materials can be made available for mushroom production. From this data, considering the standard parameters, production potential of oyster mushroom in northern Kerala is estimated as 1.5 million tons. This clearly indicates that there exists immense scope for mushroom cultivation in northern Kerala.

Table 7. Estimated production of crop residues and their potentiality for Mushroom production in Northern Kerala +

Crop residue	Production (in 1000 tons)		Estimated mushroom yield (tons)* *
	Total	25% of the total*	
Paddy straw	100	25	15024
Coconut leaf	10729	2682	1341000
Arecanut leaf sheath	400	100	50000
Banana pesudostem	1020	255	127000
Pulse stalks	3.27	0.8	408

* It is estimated that 25% of the agrowastes will be available for mushroom production

* * Bio-efficiency of 50% is considered for calculation purpose.

* Estimates based on the data from Farm Guide, 2005

1.8 Economics of cultivation

From the past experience and from various data collected from farmers' field, the average cost of production of oyster mushroom ranges from Rs.30 to Rs.40 per kg. depending on the cost of paddy straw and other items used for its cultivation. The average wholesale rate ranges from Rs.60 to Rs.75 per kg. for fresh mushrooms. The range of retail prices varies from Rs.80 to Rs.100. Thus it is apparent that mushroom cultivation in Kerala is a viable proposition provided there are proper channels for marketing. In Kannur and Kasaragod districts, there are good markets in towns like Kannur, Thalassery, Kasaragod, Payyanur, Kanhangad and Taliparamba where mushrooms can be easily sold. There is demand for mushroom from the hotel industry in these towns, provided a regular and continuous supply of mushroom is assured.

2. ROLE OF KERALA AGRICULTURAL UNIVERSITY IN MUSHROOM RESEARCH AND DEVELOPMENT IN NORTH KERALA

The Kerala Agricultural University is the principal institution in the state providing human resources and technology required for the sustainable development of agriculture, encompassing all production activities based on land and water, including crop production, animal husbandry,forestry and fisheries. The University fulfills its obligations and commitments through a network of 36 big and small campuses spread throughout the state Kerala Agricultural University supports various activities on mushroom research and development in North Kerala through Regional Agricultural Research Station, Pilicode, College of Agriculture, Padnekkad, and Krishi Vijnan Kendra (KVK) Kannur located at Panniyoor.

2.1. R. A. R. S., Pilicode as the centre stage of mushroom research and development

Coconut Research Station, Pilicode was established in 1916. Under the NARP scheme, this station has been recognized as a Regional Agricultural Research Station for the northern region comprising the districts of Kasaragod, Kannur, Kozhikode and Malappuram with effect from 1st June 1980. In the beginning, the activities were centered around research on coconut. Consequent to the implementation of NARP, research activities were undertaken in other areas also.

Mushroom research in Kerala was initiated at the College of Agriculture, Vellayani, Thiruvananthapuram during 1976. The technology slowly got disseminated to surrounding areas. However, there was practically no source for getting neither technology nor mushroom spawn in the northern districts of Kerala, situated about 600 km away from Thiruvananthapuram. Hence, during 1989, Dr. M.Govindan and Sri P.K. Sathyarajan submitted a proposal for starting a mushroom training center and subsequently initiated necessary actions at Regional Agricultural Research Station, Pilicode. In 1991, the training programme as approved by the Central Training Institute; Kerala Agricultural University was started at Regional Agricultural Research Station, Pilicode. Initially, Dr.T.Premanathan, Asst. Professor was incharge of the training. During 1993, Dr.M.Govindan, Associate Professor took charge of training and started the Microbiology laboratory, mushroom spawn

production laboratory and demonstration units. Later, mushroom spawn production was brought under the seed and nursery programme. Research, development and extension activities were gradually strengthened. The release of technology and training programmes brought an awareness among the farming community and unemployed youth. The responses were low in the first 2-3 years and from then, adoption has taken a big leap. The impact of the various research and development activities carried out in this centre during the last 10 years is reviewed in the subsequent sections.

2.2 Mushroom training and development activities at COA, Padnekkad.

College of Agriculture, Padnekkad, Kasargod District was established in 1994 under the Kerala Agricultural University. Mushroom spawn production was initiated for teaching students as a part of course work. Sri M.Joy , Asst Professor, Plant Pathology was in charge of this programme. With his initiative training programmes were conducted and spawn production carried out for distribution to the farmers participating in the agroclinic programmes. Dr. M. Govindan, Associate Professor took charge of the Department in July 2005 and the activities in mushroom picked up momentum under his leadership and with a team of Scientists including Dr. I. John kutty, Associate Professor (Agronomy), Dr. Latha Bastine, Associate Professor (Agri.Economics) Dr. K.M. Sreekumar, Asst. Professor (Entomology), Dr. Pradeep kumar, Asst. Professor (Biotechnology) and Smt. Mini.P.K. Asst. Professor (Agri Engg). Dr. Sible, Asst. Professor (Plant Pathology) has joined the Department in November 2005 and he is also associated with this programme.

An area of great concern in the diffusion of benefits of mushroom technology is the availability of spawn and centres for proper skill development. This problem is being approached in three ways.

1) Production and supply of mother spawn and bed spawn of oyster mushroom and milky mushroom.
2) Provide training programmes to cater the needs of various sectors.
3) Standardise techniques to maximize productivity, profitability , stability and sustainability of mushroom production.

At present there is no externally funded scheme to provide sufficient manpower required for these activities. Utilising the minimum resources available in the Dept of Plant Pathology, and agroclinic project of the Kasargod Distict Panchayat which is functioning at College of Agriculture, Padnekkad, pure culturing, preparation of mother spawn , bed spawn and training programmes have been started under the revolving fund scheme. Many growers approach directly and over phone seeking suggestions and recommendations for the multitude of problems arising while growing mushroom. A project is in pipe line to establish a separate laboratory for mushroom technology.

3. INFRA STRUCTURE DEVELOPMENT

Regional Agricultural Research Station, Pilicode is well equipped to carry out research, development activities and training programmes in mushroom production. Laboratory facilities, land, seminar hall, lecture hall, and hostel facilities are available. A few of the facilities established in connection with the mushroom programmes are listed below

3.1 Micro biology Laboratory

The existing Microbiology laboratory of Regional Agricultural Research Station, Pilicode was strengthened in 1993. After renovation, sterilization room, inoculation room and spawn production rooms were established. Equipments, fixtures, furniture and chemicals were procured.

Large number of people visit the mushroom culture laboratory every year to get acquainted with information on mushroom and also to find solutions to their problems in mushroom cultivation.They include not only farmers, but unemployed youths, high school teachers, VHSE lecturers, VHSE students and PRI functionaries.

3.2 Staff associated with this programme

Scientists:

i. Dr.M.Govindan, Associate Professor & Principal Investigator (1993-June 2005)

ii. Smt. Yamini Varma, Asst.Professor & Associate (2000 – 5-10-2002)

Lab.Assistants:

i. Sri.Velayudhan(1992-1998)

ii. Sri.V.Narayanan (1998- 31-8-2003)

iii. Sri Radhakrishnan (1-9-2003- till date)

3.3. Field laboratory unit on Mushroom production at R.A.R.S, Pilicode

One of the important components of mushroom research and development activities is to conduct experiments and demonstrate the technology. There was no such facility available at Regional Agricultural Research Station, Pilicode earlier. To overcome this constraint, a field unit was established in 1986. A cost effective structure of 50 sq.m floor area, utilising locally available material was constructed at a marginal expense of Rs 14,000 with all the infrastructure facilities like water supply, facilities for soaking straw, furnace, racks etc. Many growers and entrepreneurs visit this unit to get acquainted with the technology.

3.4. Mushroom demonstration unit at R A R S, Nileshwar

The Regional Agricultural Research Station, Nileshwar is situated about 10 km away from Pilicode. Considering the request from Agricultural Officers and farmers, a mushroom

production unit (8 m x 5 m) was started in 1986 in this station also. This unit is attached to the Information-cum-Sales center at Nileshwar.

3.5. Bio-composting unit

In any mushroom farm, disposal of spent substrate is very important. Heaping the materials near the production unit will attract pest and disease problems. Hence it is always advisable to utilise them properly. Very cheap and efficient method is bio-composting.In order to carry out field experiments and demonstrate the technology to farmers about the recycling of spent straw, a bio-composting unit is functioning. A temporary shed (11m x 5m) with RMP roofing was constructed at cost of Rs12,000 in 1986. Tanks of size 1m x 1m x 0.5m were also constructed to carry out replicated trials on composting using Spent Mushroom Substrate (SMS) and other materials. SMS was found to be a good substrate for vermiculture and production of vermi compost in trials conducted earlier. Field scale testing was conducted utilizing this facility and the results were confirmed.

3.6 Trainees hostel

A well-furnished hostel to accommodate trainees, resource persons and officials was constructed with the NARP funding. This facility is being utilized for mushroom training programme to accomodate the trainees.

4. TECHNOLOGY TESTING AND DEVELOPMENT

4.1 Research programmes

Various research programmes relating to mushroom production were carried out at Regional Agricultural Research Station, Pilicode.These programmes were funded by Kerala Agricultural University, National Watershed Development Programs for Rainfed Agriculture (NWDPRA) and Department of Agriculture (Adaptive trials and Front Line Demonstrations). The salient findings are listed below.

4.1.1. Identification of cheap and locally available raw materials

It is an unfounded belief among the growers that oyster mushroom cultivation is profitable only by using paddy straw. In the hilly tracts of Kannur and Kasaragod Districts, availability of paddy straw is one of the important constraints in mushroom cultivation. Different agricultural wastes as well as the local species of grasses (*Themida, Erograstis*), were tried for mushroom production. Cultivation was done as per standard procedure. After incubation for 18 days, polythene cover was removed and cropping was done till 50th day.

Bags were sampled at 0, 24th and 50th day of cropping. Five hundred gram of each samples were drawn from three bags and dried to constant weight at 60^{0} C to determine the dry weight of the substrate.

Mature fruiting bodies were harvested and weighed immediately. The total yield per bag was obtained and biological efficiency was calculated

$$\text{Biological efficiency (\%)} = \frac{\text{Fresh weight of mushrooms per bag x 100}}{\text{Dry weight of the substrate per bag}}$$

Maximum yield was obtained by using Paddy straw (86.21% BE) .It was found that Banana pseudostem (84.12% biological efficiency), coconut leaf sheath (80.31 %) ,banana leaves(75.11%) and local grasses(72.42%) also can be used for mushroom production. Coir pith and arecanut husk were very poor substrates (41.13% and 35.17%). Beedi leaf wastes mixed with paddy straw could be used for mushroom production. By carrying out the experiments with farmer's participation they were convinced about the utilitarian value of these agrowaste materials.

Table 8: Yield performance of *P.sajor-caju* on different substrates

Substrates	Substrate weight (g) at different intervals (days)		Substrate weight lost Total (g)	Mush-room yield (g)	Biological efficiency %
	0	50			
Banana pseudostem	600.4	287.2	313.2	505.1	84.12%
Coconut leaf sheath	750.8	315.5	435.5	602.9	80.31%
Local grasses	750.2	382.7	367.5	543.3	72.02%
Banana leaves	650.5	295.8	354.7	488.6	75.11%
Coir pith	500.6	385.3	115.3	205.9	41.13%
Arecanut husk	600.4	481.4	119	211.2	35.17%.
Arecanut leaf sheath	700.1	287.5	412.6	420.9	60.12
Paddy straw	750.3	361.5	388.8	645.2	86.21
Beedi leaf wastes + paddy straw	670.2	398.4	271.8	425.5	63.5

4.1.2. Selection of promising types of oyster mushroom

Experiments to determine promising types under grower's field conditions were carried out in Udayapuram and Ramanthali during 2000-2001. Different promising types of oyster mushroom obtained from the culture collection of Dept of Plant Pathology, College of Agriculture, Vellayani were used for the study. Cultivation was done as per standard procedure using paddy straw as the substrate.

Mature fruiting bodies were harvested and weighed immediately. The total yield per bag was obtained and biological efficiency was calculated as described earlier.

Maximum biological efficiency was obtained in Pe-VI and DK-3 (60.0%) followed by PV2 (46.4%). However with respect to organoleptic characters, DK-3 was found better (Table 9).

Table 9: Performance of promising types of oyster mushroom

Mushroom type	Days for first harvest	Length (cm)	Size of Mushroom (cm^2)	Bud mortality (%)	Biological efficiency
PV2	12	2.0	26.0	10.0	46.4
S.Hol	23	3.3	23.5	26.0	25.8
Pe-VI	11	1.5	16.0	0.0	60.0
VM-1	17	5.8	40.0	0.0	30.4
DK3	20	3.5	13.3	5.0	60.0

4.1.3 Selection of medium for growing mushroom fungi

Potato Dextrose Agar (PDA) medium or oatmeal agar is most commonly used for culturing mushroom fungi. Experiments were carried out to determine alternative media which are chap and easy to handle. Rice gruel supplemented with 1.5 % agar was compared with other standard media like oat meal agar media and PDA . Pure cultures of different types of *Pleurotus* were grown in petriplates containing potato dextrose agar medium. After five days uniform discs with fungal growth were collected using cork borer and transferred to Petri plates containing the various media above mentioned. It has been found that PDA can be substituted by Rice gruel agar, which is economical and readily available. Apart from *Pleurotus* many other fungi grow very well in this medium.

4.1.4 Influence of coirpith and coirpith compost on soil microorganisms and plant growth.

Kerala accounts for more than 75% of total production of coir in the country. Coir pith or coir dust is a byproduct of the industry which is now being thrown away as waste. In fact the accumulation of coir pith around defibering units due to difficulty in disposal has been creating environmental problems and even polluting drinking water. The raw coirpith is recalcitrant lignocellulosic waste, containing 8-12% soluble tannin like phenolics that inhibits plant growth and microbial activity. One of the important applications of mushroom technology could be composting huge quantity of coirpith available in Kerala. In the present context of increased interest on organic cultivation, rapidly diminishing cattle population and decreasing sources of green manure production of cheap organic manure is essential. Coirpith composting using *Pleurotus* can provide employment opportunities in production and sale of organic manures and also necessitate additional demand for mushroom spawn.

Data were collected from primary and secondary sources to assess the status of production and availability of coirpith compost in Kasaragod District and to estimate the potentiality of organic matter production by way of coirpith composting in North Kerala. The data are presented in Table.10.

Table 10: Status of coir pith production in Kasargod District.

Particulars	*Remarks*
Number of mechanical defibring units in Kasargod District	10
Number of manual defibring units	6
Average capacity of one mechanical defibring unit	6000 husks per day
Cost of husks	Rs 250/1000 nos
Production of fibres from one mechanical defibring unit	480 kg/ day
Annual production of coir pith in Kasargod District	1267 tonnes
Utilisation of coir pith for composting	6%
Utilisation of coir pith for mulching	5%

Kerala produces 5536 million nuts/year of which the share of Kasargod District is 469 million nuts. From the data it is seen that only 0.02 % of the husk produced in Kasargod District is used for production of coconut fibre and coirpith. Considering the production of 2636 million nuts in North Kerala (comprising of Kasargod , Kannur and Kozhikode Districts) and assuming that due to the enhancing demand for coir fibre, factories will be set up to convert at least 0.1% of the coconut husk available, 23000 tonnes of coirpith will be available for composting. This will create an additional demand for 34,500 kg mushroom spawn per year and an estimated production of 13800 tons of marketable compost.

The main objectives in applying organic matter are to supply balanced plant nutrition and to increase soil fertility. The ability of organic materials to achieve these results are strongly influenced by their composition, level of compost maturity, decomposition process in soil as well as their nutrient content.

Table11: Influence of raw coir pith on soil pH*

Sl No	Type of soil	Without coir pith	With coir pith	% increase
1	Sandy soil	5.78	5.80	3.46
2	Laterite soil	5.55	5.75	3.60

* Data represent mean of five replications

Table 12: Influence of raw coir pith on soil microbial population

Sl No	Microorganisms	Sandy soil without coirpith	Sandy soil with coirpith	laterite soil without coirpith	laterite soil with coirpith	CD (0.05)
1	Bacteria CFUx10^7	12.9	7.57	14.89	2.09	2.2
2	Fungi CFUx10^4	26.86	21.54	34.7	26.54	2.6
3	Actinomycetes CFUx10^5	7.47	10.43	20.70	29.01	2.3
4	Nitrogen fixers CFUx10^4	2.14	6.06	3.04	18.09	2.3
5	Phosphate solubilisers CFUx10^5	4.3	5.55	12.31	17.41	1.4
6	Cellulose decomposers CFUx10^2	6.0	15.0	30.0	230.0	6.5

Table 13: Influence of coir pith and coir pith compost on seedling vigor and root surface area

Sl. No	Treatments	Vigor index			Root surface area		
		Rice	Cucumber	Green gram	Rice	Cucumber	Green gram
T1	CP:Soil (1:0)	795.9	1038.0	791.7	30	25	10
T2	CP:Soil (1:1)	1028.0	1495.0	1457.4	40	30	10
T3	CP:Soil (1:2)	1324.8	1813.0	1870.5	60	40	20
T4	CP:Soil (1:4)	1606.4	2041.6	2420.8	70	50	25
T5	CPC:Soil (1:0)	1062.9	1413.7	984.2	40	20	10
T6	CPC:Soil (1:1)	1631.7	1888.0	2159.0	60	30	20
T7	CPC:Soil (1:2)	1930.4	2074.0	2592.0	70	50	35
T8	CPC:Soil (1:4)	2007.3	2278.8	2589.7	80	80	40
T9	Control	1398.4	1807.0	2460.5	40	40	35
CD (0.05)		178.1	163.2	185.2	9.6	8.7	4.5

Vigor Index = Germination per cent x Total length of seedlings.

Root surface area: Determined as per Carley and Watson (1966) and expressed as mg/$Ca(NO_3)_2$.

Dumping coir pith in sandy and laterite soils increased the soil pH (Table11). Singh *et al.* 1992 reported that organic reducing substances found during decomposition of manure will reduce Fe and Mn oxides causing soil pH to raise. Increased soil pH also result through mineralization of organic anions to CO_2 and H_2O, thereby removing protons.

Dumping coir pith in sandy and laterite soils reduced bacterial population (41.31% and 85.46% respectively) and fungal population (19.81% and 23.52% respectively) (Table12). Ramamoorthy *et al* (1999) reported that generally the population of soil microorganisms like bacteria and fungi might be reduced by the effect of tannin like phenolix contained in the raw coir pith. The presence of raw coir pith in sandy and laterite soils increased the actinomycete population. It was in congruent with the observations of Theradimani *et al* 1993 that the streptomycetes population was more due to the presence of coir pith.

The nitrogen fixers in the soil are having an important role in maintaining soil fertility and improving plant growth. The soil samples collected from coir pith dumped sandy and laterite soils had much higher population of diazotrophs. Loganathan *et al* 1979 reported that coir pith incorporation in soil increased the nitrogen content, possibly due to positive influence in nitrogen fixing bacteria.

The P- solubilising microbial population was increased in both sandy and laterite soils due to dumping of coir pith. The effect of dumping coir pith not only affects the specific

group of microorganisms, but may also influence their enzymatic activity. One of the important observations is the higher population of cellulolytic bacteria in coir pith dumped soils. Both sandy and laterite soils showed the same trend. Jothimani 1994 reported that the coir pith having 29% lignin and 32% cellulose was utilized by cellulose degraders. The metabolic products released by these organisms enhance the population of other important soil microbes.

Influence of coir pith and coir pith compost on the vigor and root surface area of the germinated seedlings of rice, melon and green gram were studied. Various combinations of coir pith (CP), Coir pith compost (CPC) and soil were used as growth medium. Observations were recorded in 6 day old seedlings (Table13). Untreated coir pith inhibit germination of rice melon and green gram. But the compost prepared using Pleurotus sajor-caju enhanced the seedling growth and root surface area.

4.1.5. Effect of coirpith compost in banana and arecanut

Mushroom spawn can be used for composting of coirpith. Hence trials were carried out under NWDPRA at Kattipoil during 1997-98. Beneficial effects of coirpith compost were recorded in banana and arecanut. In banana, T3 treatment with 25% Farm Yard Manure, 75% coir pith compost along with fertiliser application as per POP resulted in maximum yield. This was followed by application of coir pith alone along with fertiliser as per POP. However, they were on par. T3 was significantly superior to T1 -FYM + NPK as per Package of Practices Recommendations. Moreover, in terms of economic benefit, T3 required Rs 16175 = w/ha towards cost of organic manure, while T1 required Rs.37500 = w T3 resulted in an additional income of Rs. 12500 = w more than T1 by the sale of banana fruits making the total benefit to Rs. 33825/ha Table 14.

Table 14: Effect of coir pith compost on the yield of banana

Sl No	Treatment	Yield (Kg/Plant)	Cost of organic manure input./ha.
T1	FYM+ 100% NPK	8.75	37500
T2	CPC+100% NPK	9.00	10000
T3	FYM 25% + CPC 75% + 100% NPK	9.25	16175
T4	Org Manure as per farmers practice +100% NPK	6.90	12500
T5	FYM+ 75% N+ 100% P & K	6.50	37500
T6	CPC + 75% N+ 100% P & K	6.80	10000
	CD (0.05)	0.425	

FYM: Farm Yard Manure CPC: Coir pith compost.

4.1.6. Effect of application of coirpith compost in vegetables and coconut

Experiments using coir pith compost were laid out under adaptive trails and front line demonstrations during 1999-2000 and 2000-2001. Test crops were vegetables (the trials at Agricultural Farm, Pullur-Periye), coconut (District Agricultural Farm, Taliparamba) and vegetables (District Agricultural Farm, Thamarassery). The coirpith compost was found to be a good organic manure and its usefulness was convincing to the Department officials as well as farmers.

When organic manures were given in the form of coir pith compost, the yield of cow pea was 2750 kg/ha compared to the yield obtained from plots treated with farmyard manure and coirpith compost (2625 kg/ha) Table 15. The same trend was observed in cucumber also. In melon vellari application of coir pith compost and cow dung (in the ratio of 1:1) was found better in promoting early growth of seedlings than farmyard manure alone. At 10 days growth, the difference was 32.98 % with respect to plant height and 12.36% regarding the number of leaves. These studies clearly indicated that coir pith compost could be substituted for farmyard manure. The cost analysis for application of organic manure also shows that coir pith compost is cheaper than other organic manures. Cost of materials and labour for application of 100kg farmyard manure is Rs 170 /= where as for coir pith compost preparation, transportation and application , the cost is only Rs 75/-. The yield of melon (vellari) also was higher when coir pith compost was applied (Table 16).

An experiment was conducted in farmers' field at Puthupady, Calicut District in order to find out the effect of coir pith compost in ash gourd. The soil has a pH 5.8, organic carbon 1.15% (class 5:medium), P_2o_5 :4.0 Kg/ha (class 1: low); and K_2O : 118 Kg/ha (class 3 medium).Three treatments of organic manures were given at the rate of 25t/ha as basal application. a) Farm Yard manure, b) Coir pith compost alone, c) Coir pith compost + cow dung (50 : 50). The results indicated that i) application of coir pith compost and cow dung in equal quantities is superior with respect to growth and yield. ii)The economic benefit in terms of substituting FYM with 50% coir pith compost resulted in saving Rs.20,000/-/ha. iii) The cost of organic manure can be reduced by 40%. iv) The coir pith compost helps in soil moisture conservation and thus help plants from water stress.

Table15: Effect of application of coirpith compost on the growth and yield of vegetable cowpea

Treatments	Organic manure	Quantity tons/ha	Pod yield Tons/ha	No. of nodules/plant	Dry weight of nodules/plant
T1	Coirpith compost	20	2750	67.67	0.300
T2	Coirpith compost+ FYM (1:1)	20	2625	66.33	0.203
T3	Farmer's practice	10	2537	70.00	0.140

Data represent mean of six replications.

Plot size: 2 cents .

Table 16: Effect of application of coirpith compost on the yield of melon (vellari)

Treatments	Organic manure	Quantity tons/ha	Yield tons/ha	Cost of organic manure input (Rs)
T1	Coirpith compost	20	34.25	15000
T2	Coirpith compost+ FYM (1:1)	20	32.75	25000
T3	Farmers practice	10	31.75	17500

Data represent mean of six replications.

Plot size: 2 cents .

4.1.7. Effect of vermicompost application in Bhendi

With a view to study the effect of vermicompost on crop growth and yield, an experiment was conducted at the Regional Agricultural Research Station, Pilicode with bhendi as the test crop. The results indicated that vermicompost enhanced the growth and yield of bhendi. The biometric characters such as number of leaves, height of the plants and number of branches varied significantly Table 17. Application of 100% vermicompost gave the maximum yield, which was on par with that of T2 (75% vermicompost+25% farmyard manure.

Table 17: Biometric characters and yield of Bhindi as influenced by the application of Vermicompost

Sl No	Treatment	One month after planting			At harvest	
		No of leaves	Plant height (cm)	No. of branches	No. of fruits	Fresh weight of fruits g/plant
T1	100% Vermicompost	5.97	25.46	2.70	4.94	176.03
T2	75% Vermicompost+ 25% FYM	5.88	24.31	2.11	4.10	124.91
T3	50% Vermicompost+ 50% FYM	5.63	23.94	1.63	4.00	106.09
T4	25% Vermicompost+ 75% FYM	5.59	22.74	1.58	3.30	105.20
T5	100% FYM	5.20	22.16	1.45	2.76	71.09
T6	No organic manure	4.75	16.86	1.45	2.22	47.19
CD(0.05)		0.612	2.738	1.45	1.206	54.176

4.1.8. Effect of vermicompost application in melon (Vellari)

Experiments were carried out to find the effect of vermicompost application in melon. The experiment was carried out at Manadkam. Application of vermicompost @ 25t/ha along with inorganic fertiliser gave maximum yield(11.2t/ha), followed by treatment with cattle manure (10.08t/ha). It indicates that vermicompost is a good source of organic manure for melon (Table 18).

Table 18: Effect of vermicompost application in melon (Vellari)

Sl No	Treatments	Yield (tons/ ha)
T1	100% Vermicompost	22.40
T2	100% FYM	19.40
T3	75 % Vermicompost	19.36
T4	75% FYM	18.60
T5	50% Vermicompost	16.65
T6	50% FYM	15.75
T7	No organic manure	15.98
CD (0.05)		0.692

4.1.9. Influence of spent substrate on growth and reproduction of earthworm

Growth and reproduction of the earthworm *Eisenia foetida* on spent substrate was studied. Three substrates viz. dried cashew leaves and cow dung (7:1), dried jack fruit leaves and cowdung (7:1) and spent substrate (paddy straw after mushroom cultivation) were taken on equal dry weight basis and placed in darkness in plastic boxes with perforations in the lid. The moisture content of the substrate during the experiment was around 80% to keep the humidity conditions within the optimal limits. The resulting populations were studied in numbers and biomasses by cocoon production, different size classes and fertility stage for a period of 240 days. Among the various substrates studied, spent substrate was found to be better . The total number of clitellate worms and cocoon production reached a peak in a short period on spent substrate Table 19.

Table 19: Influence of spent substrate on growth and reproduction of earthworm

Days	Total No. of clitellate worms			Cocoon production		
	S1	S2	S3	S1	S2	S3
25	3.00	3.00	20.00	20.00	20.00	20.00
50	3.00	3.00	18.33	18.33	20.38	25.00
75	5.33	8.33	28.28	28.28	36.83	50.67
100	18.33	20.66	38.90	38.90	51.63	75.43
125	31.33	41.66	78.72	78.72	160.33	200.86
150	52.33	60.33	130	130.00	140.00	150.24
200	48.33	51.66	95.63	96.51	100.81	120.00
240	10.00	8.33	30.21	30.41	28.25	40.00

S1: Dried cashew leaves: Cow dung (7:1)

S2: Jack fruit leaves: Cow dung (7:1)

4.2. Spawn production and distribution

Mushroom culture laboratory at Regional Agricultural Research Station, Pilicode and College of Agriculture, Padanekad are major sources of spawn and stock culture of commercial mushroom varieties in north Kerala. Isolation, purification, maintenance of culture, mother spawn production and bed spawn production require technical expertise and aseptic high-tech laboratory facilities The various activities undertaken in this regard are presented.

4.2.1. Spawn production laboratory

The spawn production lab at Regional Agricultural Research Station, Pilicode has a work area of 230 sq.m The lay out details are as follows (Table 20).

Table 20. Lay out plan of Microbiology laboratory at Regional Agricultural Research Station, Pilicode

Lab No	Built area (sq.m)	Use
ML-1	7x4.5	Incubation
ML-2	9x6	Cooking room
ML-3	4x4	Sterilization
ML-4	6x3	Store
ML-5	3x3	Inoculation room
ML-6	2x2	Washing room
ML-7	2x2	Toilet
ML-8	7x4.5	Central computer facility
ML-9	2x31	Veranda

Since quality is assured, there is heavy demand for spawn from RARS, Pilicode and College of Agriculture, Padnekkad.

4.2.2. Distribution of quality spawn

One of the important activities of mushroom development programme is to supply quality seed material to the farmers. Mushroom cultivators from Kasaragod, Kannur, Malappuram and Kozhikode Districts obtain spawn from R.A.R.S, Pilicode. The spawn production laboratories in these districts depend on this institute for their requirement of mother spawn . The number of bottles of spawn distributed during the last ten years (month wise) is presented in Table 21.

Table 21. Distribution of quality spawn from Regional Agricultural Research Station, Pilicode

Year	Number of spawn bottles distributed												
	Jan.	Feb.	Mar.	April	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1992	28	26	-	9	-	15	15	23	29	49	74	23	291
1993	28	35	28	33	30	80	87	77	72	157	204	181	1012
1994	185	70	140	128	60	70	81	339	94	138	117	100	1522
1995	63	212	160	451	126	130	252	260	192	66	185	278	2375
1996	265	188	236	114	69	23	322	221	168	203	178	133	2420
1997	131	82	58	33	25	69	89	27	-	3	-	9	526
1998	-	-	-	-	162	25	99	56	20	42	38	69	511
1999	70	-	33	96	124	60	-	31	40	58	71	85	668
2000	106	11	42	41	91	83	71	30	59	45	35	52	666
2001	52	33	42	28	39	17	28	12	29	20	20	33	353
2002	64	8	7	22	7	19	30	19	25	35	40	85	364
2003	62	34	44	39	42	58	75	59	127	114	145	65	864
2004	96	94	218	113	102	163	247	195	266	221	93	113	1831
2005	279	285	371	268	156	279	194	264	135	111	620	560	3522

Initially the priorities were to give training in spawn and mushroom production. Hence the complete requirement for bed spawn had to be supplied from Regional Agricultural Research Station, Pilicode. Till 1996 spawn production showed an upward trend. During this period our aim was to popularize the production technology and distribute quality bed spawn. With the limited resources of our institute it is not possible to meet the increasing demand for mushroom spawn. So it was also aimed to identify groups or individuals who can establish small scale bed spawn production units, conduct training programmes and provide complete technical support. From 1996 onwards due to our continuous efforts, various entrepreneurs came forward to establish spawn production laboratories. District Panchayat/ Gramapanchayats also extended financial support in establishing spawn production units as well as in conducting training programmes. These spawn production units used to get mother spawn from this institute, multiply and supply to growers. Now the supply of

quality mother spawn to these laboratories also became our responsibility. No separate funds or staff was allotted exclusively for mushroom production/spawn production programme. This has to be carried out along with other research and teaching activities. This has been one of the important constraints in mushroom spawn production. Further, equipment like autoclave purchased long back are still being used for spawn production. Due to paucity of funds, the repair work as well as the replacement is delayed which has adversely affected the spawn production of late. Still we continue to supply mother spawn and bed spawn.

From 2005 onwards, we have started spawn production at the College of Agriculture, Padnekkad also to cater the needs of spawn requirement in North Kerala.

4.2.3 . Quality control measures

In order to ascertain the quality and yield performance of various batches of mushroom spawn produced, samples are drawn and they are tested under standard conditions. There is no satisfactory method to check and evaluate the quality of spawn by rapid on the spot examination. If no degenerative changes were to take place during the preparation or maintenance of mushroom cultures and of spawn, then the preservation of mushroom cultures would be a relatively simple routine process. Unfortunately it is not true. Degeneration leads to the loss of desired qualities by changes that result in such things as slow development, poor rate of survival and low level of productivity. Hence periodic quality testing is of great importance in mushroom spawn production.

5. TRANSFER OF TECHNOLOGY

In order to transfer the mushroom production technology, various extension methods are adopted. It includes demonstrations, adaptive trials, participatory technology development, training programmes etc. Apart from that, Kerala Agricultural University acts as a catalyst to implement the various programmes sanctioned by agencies like Department of Agriculture, Industries, Grama panchayaths and other organizations.

5.1. Training programmes

5.1.1. Objectives

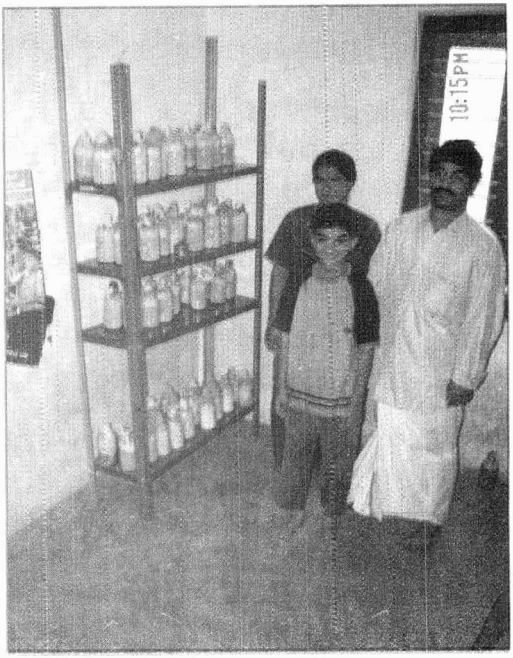
Training programmes were formulated with the following objectives:

To provide training to the growers in mushroom production with a view to promote mushroom cultivation in north Kerala.

To provide cutting edge technology and quality spawn to growers and to impart them the skills for producing bed spawn.

To encourage mushroom spawn production centers in private as well as cooperative sectors.

Empowering farm women in mushroom cultivation



Satisfied beneficiaries of mushroom growing

Training programmes were conducted regularly in the research station as well as in the villages with the collaboration of local panchayats, Krishi Bhavans, NGOs and other agencies. Training is also imparted at the school and college levels. Potential entrepreneurs from these trainings take up mushroom cultivation on scales that meet their budget.

The teaching methods include lecture, lecture notes, library assignments, board displays, demonstrations, group discussions, project work , practical, etc depending on the nature of training and duration. Various instructional aids are used for proper training. They include use of LCD projector, chalkboard, cyclostyled notes, leaflets/pamphlets, charts, posters, laboratory manual, videocassette, slides, transparency etc.

5.1.2. Beneficiaries

The beneficiaries from the programmes are mostly farmers in the rural areas, Other beneficiaries include educated unemployed youths, students, Government servants, housewives etc.

The training programmes were started during 1991. Vocational training programmes sanctioned by Central Training Institute, trainings arranged by various agencies etc are listed below.

5.1.3. Vocational training programmes for unemployed youth

Kerala Agricultural University conducts short term training programmes on mushroom cultivation. These programmes are approved by CTI. Farmers/unemployed youth are selected for the training after giving wide publicity through newspapers. A nominal amount is collected as course registration fee. A list of such training programmes conducted during the last 13 years is presented in Table 22 and 23 (the list is not exhaustive).

Table 22: Short term trainings in mushroom cultivation organised and conducted by Regional Agricultural Research Station, Pilicode

Course Director : Dr.M.Govindan

Period	Duration (WD)	No. of trainees per batch		Venue	Remarks
		Men	Women		
29-31 Oct. 1992	3	8	15	Pilicode	Kasaragod and Kannur
23-25 Nov.1992	3	11	12	Pilicode	Kasaragod and Kannur
8-10 Dec.1993	3	9	3	Pilicode	Mundallur, Karivedkam
15-17 Dec.1993	3	11	4	Pilicode	Chervathur, Kannur
7-10 Nov.1994	3	12	9	Pilicode	Nileshwar, Cherupuzha
19-21 March 1997	3	14	2	Pilicode	Karivellur, Taliparamba
18-20 March 1999	3	-	17	Pilicode	Ezhom, Mathil 22-24 March
22-24 March 1999	3	-	18	Pilicode	Ramanthali, Udayapuram
4-6 May 1999	3	-	16	Pilicode	Mavilayi
11-13 May 1999	3	-	19	Pilicode	Udayapuram Mavilayi
8, 15-17 Feb.2000	3	-	24	Pilicode	Kanhangad Kalliassery

Table 23: Short term trainings in mushroom cultivation organised and conducted by College of Agriculture, Padnekkad.

Course Director: Dr.M.Govindan

Period	Duration WD)	No. of trainees per batch		Remarls
		Men	Women	
5-10-05	1 day	37	3	Kannur, Kasaragod, Kozhikode Dist
8-10-05	1 day	21	2	Kannur, Kasaragod, Kozhikode Dist
23-10-05	1 day	26	3	Kannur, Kasaragod, Mangalore
4-11-05	1 day	22	3	Kannur, Kasaragod, Mahe
8-11-05	1 day	24	2	Kannur, Kasaragod, Malappuram
29-12-05	1 day	14	2	Kannur, Kasaragod
31-12-05	1 day	12	4	Kannur, Kasaragod

5.1.4. Training programme sponsored by Kerala State Women Development Corporation (KSWDC)

KSWDC sponsored a short-term training programme on mushroom cultivation for 3 days during 13.2.95 to 15.2.95. Five women each selected from Kannur, Kasaragod and Kozhikode districts attended the training. All of them started mushroom cultivation after the training.

5.1.5. Short term training programmes conducted in collaboration with Department of Agriculture

Department of Agriculture organises various training programmes for popularizing mushroom cultivation. Regional Agricultural Research Station, Pilicode provides technical and infra structural facilities for conducting the programme.

5.1.6. Trainers' training programme

A three day trainers' training programmme (3.11.94 to 5.11.94) covering various aspects of mushroom cultivation technology was conducted for the officers of the Department of Agriculture . 11 Agricultural Assistants from Kannur and Kasaragod Districts participated.

5.1.7 Vocational training programmes

A list of vocational training programmes is furnished in Table 24.

Table 24 : Vocational training programmes on mushroom cultivation.

Period	Duration	No. of trainees per batch		Venue	Remarks
		Women	Total		
1	2	3	4	5	6
9.1.95 to 11.1.9	3 WD	8	12	Pilicode	Karivellur Payyanur
16.1.95 to 18.1.95	3 WD	13	20	Pilicode	Mayyil KB, Mavilayi
19.1.95 to 21.1.95	3 WD	7	11	Pilicode	Wynad
27.2.95 to 29.295	3 WD	6	11	Pilicode	Wynad, Kannur

1	2	3	4	5	6
29.1.96	1 WD	8	20	Pilicode	Nileshwar
27.2.96 to 28.2.96	2 WD	15	20	Pilicode	Kanhangad, West Eleri
14.3.96 to 16.3.96	3 WD	19	25	Pilicode and RATTC	Thalassery
18.5.96	1WD	9	20	Kanathil	Kinathil
7.6.96	1WD	22	30	Pilicode	Pilicode
27.6.96	1WD	20	30	Pilicode	Cherupuzha
6.3.99	1 WD	30	21	Taliparamba	Taliparamba
31.5.99	1 WD	40	22	Pilicode	Udayapuram
6.6.99	1 WD	20	20	Pilicode	Udayapuram
24.8.99	1 WD	20	20	Pilicode	Mavilayi
17.5.01 to 19.5.01	3WD	22	22	Pilicode	Taliparamba
30.1.02 to 1.2.02	3WD	30	30	Pilicode	Madikkai Panchayath
22.3.02 to 35.3.02	3WD	15	15	Pilicode	Madikkai Panchayath
6.5.02 to 7.5.02	2WD	20	20	Pilicode	Nileswar block
7.10.03 to 9.10.03	2WD	21	-	Nileswar	Nileswar Panchayat
6.2.05 to 8.2.05	3 WD	14		Nileswar	Madikkai SH group

5.1.8. Training programmes conducted in collaboration with RUDSETI (Rural Development and Self Employment Training Institute, Kannapuram, P.O. Cherukunnu

Table 25 : Training programmes conducted in collaboration with RUDSETI

Period	Duration	No. of trainees per batch	Venue
7.3.96 to 13.3.96	7WD	20	Kannapuram and Pilicode
17.8.96 to 21.8.96	7WD	30	,,
5-6-02 to 12-6-02	7WD	18	,,

5.1.9. Training programmes conducted in collaboration with KVK, Manjeswaram (Beneficiaries: Linguistic minorities of Manjeswaram block)

Table 26: Training programmes conducted for the benefit of linguistic minorities

Period	Duration	No. of trainees per batch	Venue
22.12.93	1WD	19	Pilicode
23.12.93	1WD	18	,,
16.3.94	1WD	16	,,

5.1.10. Off campus training programme on mushroom production conducted in collaboration with Department of Agriculture and other agencies

Table 27: Details of Off campus training programme on mushroom production

Period	*No. of trainees*	*Venue*
1	2	3
20.2.92	27	Thalassery
26.10.92	28	Kallyassery
27.10.92	20	East Eleri
16.12.92	14	Pappinissery
15.7.93	25	Organised by Nehru Yuva Kendra, Anangoor
5.8.93	26	Kannur
16.12.93	25	Sreekantapuram
1.3.94	8	Watershed areas of Payyanur, Taliparamba, Edakkad, Irikkur
2.3.94	35	St.Pauls Church, Taliparamba
8.3.94	60	Tellichery, Dept. of Agri.
29.3.94	40	Attenganam
20.9.94	25	Dept. of Agri., Kutteni watershed
24.9.94	20	Taliparamba
21.12.94	8	Pilicode
31.12.94	22	Alakkod
29.3.95	5	Trikaripur
18.11.95	25	Taliparamba
16.3.96	30	Chavassery
3.7.96	30	Kannur dist.
26.4.97	24	Bandadka
13.2.98	60	Kannur dist
29.11.99	20	Kunhimangalam
30.11.99	20	Nileshwar
2.2.2000	12	Koothuparamba
14.2.00	28	Mavilayi
19.2.00	42	Kankol
18.7.00	20	RATTC

1	2	3
28.7.00	35	Beemanady
29.7.00	22	Cheemeni
24.8.00	25	Kasaragod
25.8.00	28	RATTC
19.10.00	15	Taliparamba, Payyanur and Kunhimangalam
6.4.01	32	CEE
8.2.02	23	ETC
5.6.03	34	RATTC
12.10.02	27	Kunhimangalam
4.1.03	26	Kozhikode
5.7.03	41	Kottakkal
11.9.03	33	Kondotty
22.12.03	25	Malappuram
5.2.04	22	Kannur
12.5.04	25	Thalassery
31.12.04	25	Badagara
3.5.05.	23	Kanhirapoil
11.6.05	42	Nileswaram

5.1.11. Fixed schedule programme

As indicated earlier, an Information-cum-Sales center is functioning at Nileswar. As a part of the extension activities of Regional Agricultural Research Station, Pilicode training programmes of one day duration on mushroom cultivation organised regularly on first Saturday of every month at Nileswar. This programme was continued for about two and a half years. The details about the training programmes are given in Table 28 & 29.

Table 28: Training programmes on mushroom cultivation conducted at Nileswar

Year	*No .of batches*	*No. of participants*
1994	12	114
1995	12	125
1996	6	78
Total	30	317

Table 29: Detailed list of training programmes conducted at Nileswar.

Date	No. of participants
3.1.94	8
7.2.94	7
7.3.94	10
2.4.94	5
2.5.94	15
4.6.94	12
2.7.94	11
6.8.94	17
5.9.94	10
1.10.94	4
5.11.94	8
3.12.94	7
7.1.95	8
4.2.95	10
6.3.95	12
3.4.95	11
1.5.95	2
5.6.95	6
3.7.95	4
7.8.95	8
4.9.95	12
2.10.95	16
6.11.95	21
4.12.95	15
6.1.96	3
3.2.96	10
2.3.96	20
6.4.96	15
4.5.96	12
1.6.96	18

5.1.12 Training programme on mushroom cultivation for SC/ST

A training programme of six days duration was conducted for the benefit of SC/ST youths of Kasaragod District. The programme was funded by the District Collector, Kasaragod. It was conducted during 10th to 15th March 1997 and various aspects of spawn production, cultivation, marketing and preparation of recipes etc were covered. Seven unemployed youths from Nileswar, Kasaragod and Kanhangad blocks participated. Their minimum educational qualification was SSLC. Two of them started commercial cultivation but discontinued later due to various personal reasons.

5.2. Preliminary awareness programmes (Public seminars)

Apart from trainings, a number of awareness classes on mushroom cultivation were also conducted.

Table 30. List of preliminary awareness programmes (Public seminars)

Date	*Venue*	*Agency*
9.2.1994	Pallikkare	Krishi Bhavan
11.3.94	Sreekantapuram	Krishi Bhavan
16.3.94	Mathamangalam	Krishi Bhavan
30.4.94	Chittarikkal	Krishi Bhavan
13.5.94	Cherupuzha	Farmers' Society
15.11.95	Kozhummal	Prachothana Charitable Society
23.1.96	Taliparamba	RATTC
30.1.96	Taliparamba	RATTC
28.12.96	Cherupuzha	Taliparamba Primary Co-operative Agrl.Devpt. Bank Ltd.
30.8.97	Payyanur	Krishi Bhavan
7.5.98	Pinarayi	Gramapanchayath
26.5.98	Dharmadam	Block Panchayath
26.5.98	Azhikode	Kannur District Panchayath
28.5.98	Kannur	Raidco Seminar
5.6.98	Attenganam	Kodom-Belur Panchayath
6.6.98	Belur GUPS	Krishi Bhavan and Kodom-Belur Panchayath
8.6.98	Kalikkadavu	Pilicode Grama Panchayath
25.6.98	Muzhakkom	Grama Panchayath
12.1.2000	Kodakkad	Kodakkad Service Co-op.Bank
24.1.2000	Kozhichal	North Malabar Gramin Bank
1.11.2001	Pilicode	Kisan Mela

5.3. Community Development Programmes

Under the community development programme of Nityananda Polytechnique, necessary technical assistance to train the farmers in mushroom cultivation was provided. Thirty farmers from Pilicode Panchayath were selected for the programme implemented during 1996. All of them started growing mushroom for home consumption and satisfactory yield was obtained. The initial enthusiasm could not be sustained due to financial constraints of the farmers and none of them took it up as a means of earning revenue. However twenty five percent of them still grow mushroom for home consumption.

5.4. Exhibitions

Dr. M. Govindan has participated in the following programmes by arranging exhibits and charts on mushroom cultivation.

Table 31: Participation in exhibitions

Period	Location	Particulars	No. visitors to the stall (approximate)
5.11.93 – 14.11.93	Padnekkad	Silver Jubilee exhibition – Nehru Arts & Science College, Padnekkad	2000
11.4.94– 14.4.94	Madikkai	Karshika Mela	800
26.4.96	Koyyod	Karshaka Mela – 96 Krishi Bhavan	500
28.12.95 - 11.1.96	Pilicode	All India Exhibition FAS Fest 95	6000
13.2.98 – 18.2.98	Kannur	Flower show 98 – Dist.Agri.Hort.Society	3000
25.12.00 – 28.1.01	Kalikkadavu	Remya Fine Arts Society	1200
30.10.01 – 1.11.01	Pilicode	Kisan Mela	400
5.8.04- 13.8.04	Kannur	Karshika Mela	500

5.5. Panchayat adoption for Mushroom Cultivation

As a part of the continuing education programme, Mayyil Grama Panchayat and Regional Agricultural Research Station, Pilicode, implemented an intensive mushroom training programme during 1994-95. Mr Prabhakaran, M (Agrl Officer, and Saksharatha Co-ordinator) and a group of people from the locality were given adequate training. They transferred this technology to about 900 people is the Panchayath. The training was conducted on all Wednesdays at Mayyil Panchayat office and on all Sundays at Kattur Akshara Sangham. Mushroom spawns were also distributed to the people. This has helped to create awareness among the rural people. Jose, who was given training started cultivation for home consumption. Four people started commercial cultivation and they are still continuing.

5.6. Earn while you learn programme

As a part of the 'earn while you learn programme', the B.Sc (Ag) students of College of Agriculture, Padnekkad took up mushroom cultivation as a programme during the year 2005. Students' union organized a team of students and arranged for practical training and started cultivation. We have provided all necessary technical guidance. Sri. Anooj, Sri Sajeesh, and Sri Ranchal are actively involved in this programme. On an average, using one packet of mushroom spawn and 3 kg paddy straw they obtained 2.5 kg mushroom. Local newspapers gave wide publicity to this new endeavour of students. This has helped to create self confidence among the agricultural students and awareness among other students.

5.7. Publications

In order to popularise the technology, different publications were brought out with the financial help of various agencies.

Leaf lets	:	2000 copies
Training manuals	:	2 Numbers
News reports	:	25 Numbers
Articles in News paper	:	5 Numbers
Kannur district development seminar (5.3.96)	:	1 Number

5.8 . Radio programmes

Four Radio programmes on mushroom cultivation were broadcasted through the All India Radio, Kannur on 9-4-1996, 6-5-2000, 24-5-2001 and 27.12.2001 Apart from this, the success stories of mushroom cultivation by Mr. Manoj, Smt Prasanna and Mr. Mohanan were also broadcasted

5.9. Television Programmes

i. Coirpith composting: A success story (Surya TV: 20.11.1998)

ii. Mushroom cultivation and training :ETV, 12-5-04

iii. Mushroom cultivation : CCN : 12-8-05

iv. Mushroom cultivation: Asianet : 21-10-05

5.10. Correspondence

Growers and interested entrepreneurs frequently send letters requesting the details about mushroom cultivation and various other practical problems. Such requests are promptly attended. The number of such correspondence and question answers is shown in Table 32.

Table 32: Number of queries on mushroom cultivation attended

Year	No.of correspondence
1992	60
1993	80
1994	75
1995	100
1996	95
1997	78
1998	120

Year	No.of correspondence
1999	140
2000	110
2001	85
2002	120
2003	98
2004	130
2005	300

5.11. Telephonic discussions

Farmers from Kasaragod, Kannur, Kozhikode and Malappuram districts contact Dr.Govindan, Associate Professor in the office as well as at residence and discuss about various aspects of mushroom cultivation and other technical aspects. On an average, 250 calls were attended in an year till 2004. During 2005, there is a boom in interest on mushroom cultivation and the number of telephone calls received enhanced substantially reaching 1500 nos. in the current year alone.

5.12. Counselling

Farmers visit the mushroom lab at RARS, Pilicode and COA, Padnekkad to get direct information about mushroom cultivation. Various problems faced by growers are also discussed. Number of farmers who visited during the period are given in Tabe 33.

Table 33: Number of people is visited mushroom laboratory

Year	No.of people visited
1992	140
1993	602
1994	650
1995	1100
1996	980
1997	250
1998	520
1999	330
2000	460
2001	250
2002	350
2003	480
2004	620
2005	950

5.13. Diagnostic visit

Mushroom growers sometimes face serious problems in cultivation. Many times scientists from Regional Agricultural Research Station, Pilicode and COA, Padnekkad go to the field and suggest remedial measures.

Sri Balachandra Menon is a progressive mushroom grower residing at Taliparamba, Kannur District. He is producing 2-5 kg of milky mushroom daily. During December 2005, his crop was seriously affected and production decreased drastically. The buds were seen emerging , but did not grow properly. On verification of samples it was found to be a serious incidence of mite attack. The fact that the milky mushroom is gaining popularity and there is very little information on pest and diseases affecting this variety, it is extremely important to document these field problems and find out their remedy.

6. IMPACT OF MUSHROOM TRAINING PROGRAMMES

The outcome of training has been classified into four categories viz. Reaction, Learning, Behaviour or performance and Outcomes or results and evaluated.

6.1 Reaction of the participants about the coverage of subject in the mushroom training

Success of mushroom cultivation as an avenue for a profitable self employment needs an exposure to the technology. Kerala Agricultural University (KAU) through RARS, Pilicode and College of Agriculture, Padnekkad has initiated programmes to train unemployed youth on various aspects of edible mushroom cultivation. After the completion of training programme, the participants were given a questionnaire , and obtained their reaction towards the subject covered. The results are presented in Table 34.

Table 34: Reaction of the participants about the coverage of subject in the mushroom training organised by KAU

Subject	Trainings of less than three days						Trainings of 3 days or more					
	Adequate		Somewhat		Poor		Useful		Some what		Not useful	
	Freq-uency	Per cent	Freq-uency	Per cent	Freq-uency	Per cent	Freq-uency	Per cent	Freq-uency	Per cent	Freq-uency	Per cent
Spawn production (theory)	80	77	24	23.1			35	77.8	10	22.2		
Spawn production (practical)			36	34.6	68	65.4	10	22.2	18	40.0	17	37.8
Lay out of beds	91	87.5	13	12.5			43	95.6	2	4.4		
Growing mushrooms	78	75	26	25			42	93.3	3	6.7		
Control of pests and diseases	62	59.6	42	40.4			37	82.2	8	17.8		
Waste utilization	83	79.8	21	20.2			32	71.1	13	28.9		
Coir pith composting	90	86.5	14	13.5			41	91.1	4	8.9		

It can be seen that topics covered in short term (less than three days) training programmes are adequate for small scale growers. More than 78% participants expressed that lay out of beds and growing mushrooms was adequately covered. But practicals on mushroom spawn production was not covered adequately. However 22.2 % suggested that coverage of spawn production is adequate in 3-5 days training .But 40 % opined that 3-5 days is only some what adequate for spawn production.

6.2. Motivational factors for joining the training

In order to make necessary changes in training it is imperative to analyse the factors which motivated the learners. Kerala Agricultural University, various Govt. agencies (like Grama Panchayath, Krishibhavan, RATTC), NGOs and commercial growers organize mushroom trainings of varying duration. Eight statements which could be the possible motivational factors to join the training programme on mushroom cultivation were given and asked to point out the most significant one as perceived by them. The results are given in Table 35.

Table 35: Motivational factors for joining the training

Item	Organized by KAU		Other agencies		Commercial growers	
To adopt as an occupation/livelihood measure	68	65.4	26	26.8	8	20
To grow mushroom for self consumption	20	19.2	30	30.9	2	5
To acquire knowledge about mushroom	6	5.7	22	22.7		
To obtain additional knowledge	4	3.8	0	0		
For the sake of getting certificate	2	1.9	12	12.4		
For the sake of attendance (since selected by the agency mostly)	0	0	7	7	2	
To establish linkage with KAU	4	3.8	NA	NA	NA	NA
Attracted by the catching advertisement that huge profit can be realised through mushroom cultivation					30	75

65.4 % of the respondents stated that the motivation to attend the trainings organized by KAU was to adopt it as an occupation/livelihood measure. But 75 % of the trainees attending trainings of commercial growers were attracted by the catching advertisement that huge profit can be realised through mushroom cultivation.

6.3. Knowledge gained by the participants as a result of the training

A training to be effective is expected to deliver knowledge and skill to the participants. In order to assess the extent of knowledge gained by the participants as a result of the training, responses were collected through personal contact, discussions and telephonic conversations. Results are presented in Table 36.

The responses from the trained persons were encouraging. Majority of them gained very good knowledge on lay out of beds (96.1%), growing mushrooms (100%), control of pests and diseases (100%) and waste utilization (89.4%)

Table: 36 Knowledge gained by the participants as a result of the training

Item	Very good		Good		Poor	
	Freq-uency	Per cent	Freq-uency	Per cent	Freq-uency	Per cent
Nutritive value of mushrooms	38	36.5	62	59.6	4	3.8
Spawn production	9	8.6	81	77.7	14	13.5
Lay out of beds+-+	100	96.1	4	3.8		
Growing mushrooms	104	100				
Control of pests and diseases	104	100				
Waste utilization	93	89.4	11	10.6		
Coir pith composting	60	57.7	30	28.8	14	13.5
Identify edible and poisonous mushrooms	35	33.6	58	55.7	9	8.7
Processing	41	39.4	48	15	14.4	
Formation of self help groups and decentralized production system.	23	22.1	43	41.3	38	36.5

6.4. Suggestions for further improvement of the mushroom training

The trained persons were asked to give their suggestions for further improvement of the training . After collecting details from 104 persons, they were grouped and the per cent worked out.

Table 37 : Suggestions for further improvement of the mushroom training

Item	Freq-uency	Per cent
1	2	3
Conduct public awareness programmes on preliminary aspects of mushroom cultivation	28	26.9
Conduct short term training (One day) on mushroom cultivation	11	10.6

1	2	3
Increase duration of training to 3 days	14	13.5
Conduct hand on training in mushroom spawn production for 5 days	16	15.4
Give publicity on the benefit of mushroom through mass media	8	7.7
Give more importance to practicals	6	5.8
Organise periodical seminars of growers	8	7.7
Create awareness about financial support from various agencies	4	3.8
Give more stress on post harvest technology	7	6.7
Class to be handled to cope up with the comprehension level of trainees	2	1.9

Conduct public awareness or training programmes on preliminary aspects of mushroom cultivation, conduct hands on training in mushroom spawn production for 5 days and give publicity on the benefit of mushroom through mass media were the important suggestions.

6.5 Constraints in the cultivation of mushrooms

On completion of the training programme, participants were supplied with spawn bottles of *Pleurotus* to practice the cultivation at home. After allowing a reasonable period for putting the technology into practice, a feed back from the trainees who underwent training from KAU, Govt. Departments, Commercial growers and NGOs were collected through interviews, discussions, (both direct and through telephone) and questionnaires. The results are given in Table 38.

Non availability of spawn was a major constraint expressed by 24.04% of the participants. This was followed by problems in marketing, non availability of substrate and inadequacy of finance.

Table 38: Constraints in the cultivation of mushrooms

Sl No	Constraints	Frequency	Percent
1	Problems in marketing	10	9.61
2	Non availability of spawn	25	24.04
3	Poor shelf life	5	4.81
4	Lack knowledge about poisonous mushrooms	3	2.88
5	Less profitability	7	6.73
6	Non availability of substrate	10	9.61
7	Inadequacy of finance	10	9.61
8	Lack of space for shed	5	4.8
9	Non availability of proper management	8	7.69
10	Non availability of good quality water	4	3.85
11	Lack of family support	3	2.88
12	Other reasons	4	3.85
13	Erratic production	8	7.69
14	Crop failure	2	1.92
	Total	104	100

6.6. Causes of production problems in Mushroom cultivation

Efforts were made to identify the important problems faced by mushroom growers of north Kerala. Individual farms were visited and farmers contacted to collect the data. The details are given in Table 39.

Insect and fungal contaminations were the main reasons for low yield (40% and 30%) respectively.

Table 39: Causes of production problems in Mushroom cultivation

Sl No	Reasons	Frequency	Per cent
1	Insect pest	12	40
2	Fungal contamination	9	30
3	Problems of maintaining humidity	5	16.7
4	Lack of proper after care	7	23.3
5	Lack of proper technical skill	2	6.7
6	Quality of spawn purchased from outside agencies	4	13.3

In majority of the farms , major problem was insect attack. Phorid flies, Sciarid flies, Spring tails, beetles, mites etc were found attacking the crop. Proper control measures were recommended to the farmers during the visit.

7. ADOPTION OF TECHNOLOGY

7.1. Selected indicators of progress in mushroom development in Kannur and Kasaragod Districts

The various activities undertaken by Regional Agricultural Research Station, Pilicode have created a lot of awareness among the people about mushroom cultivation and at present several people have taken up mushroom cultivation as a self-employment avenue. A large number of rural people produce mushroom for home consumption. Its high nutritive value can solve the protein deficiency in the rural people. A faster growth of mushroom industry in Kerala is expected in the years.

An overview of the current status of production of mushroom, mushroom spawn and coirpith compost in Kannur and Kasaragod districts (2005) is presented in Table 40.

Table 40 : Current status of production of mushroom, mushroom spawn and coirpith compost in Kannur and Kasaragod districts

Items	*Details*
1	2
Mushroom spawn production units	12 Nos
Mushroom production units (commercial)	25 Nos
Mushroom spawn production	55000 bottles
Sale of mushroom spawn by outside agencies (From nearby states or districts)	10000 bottles.

1	2
Mushroom production	82500 kg.
Mushroom production (commercial)	30000 kg
Production in terms of protein	4160 kg
Economic value of spawn	Rs.8,25,000/=
Economic value of mushrooms	Rs.95.63 lakhs
Composting coirpith using *Pleurotus*	1500 tones
Economic value of compost	Rs.45 lakhs
Employment generation (Per year)	38900 days
Employment generated so far	544600 days
Number of people trained in mushroom cultivation and spawn production	3610 Nos
Number of people acquired preliminary knowledge about mushroom cultivation	10800 Nos

The data were computed based on the details collected from mushroom growers, whose details are given separately.

Table 41: Mushroom spawn production units in Kannur and Kasaragod districts established with the technical assistance from Regional Agricultural Research Station, Pilicode

Sl. No.	Name	Year	Phone No.	Spawn production (Bottles/yr)	Mushroom production (kg/day)
1	2	3	4	5	6
1	Akhilesh. K.V Anugraha, K.O.Road Kadachira(P.O.), Kannur	2005	0497 2822584	5000	5
2	Balachandra Menon, Chiravacku Thaliparamba, Kannur Dt.	2005	0497 2822584	6000	5
3	Balachandran Master, Shadikkavu Kumbala, Kasaragod Dist.	2005	9446 039146		20
4	Mushroom spawn production unit, Udayapuram, Odayamchal, via-Kanhangad, Kasaragod Dist.	1999	0467 2246423 (Mr.Justin)	6000	20
5	Girija, Athinjal, Kanhangad, Kasaragod Dt.	2001	0467 2707059		3
6	Smt. Prasanna Damodaran, Rama Nilayam, Ramanthali P.O, Payyanur, Kannur Dt.	1998	0498 522222	4200	2
7	Kalliassery Vanitha Mushroom spawn production unit, Kalliassery south, Anchampeetika, Kannur Dt.	1998	0497 786475 (Mr.Manoj)	6000	2
8	Kairali Mushrooms, Near CRC Kalliassery, Kannur-670562	1999	0497 780297 (Mohanan)	8400	5

1	2	3	4	5	6
9	Canara Agro researchers and growers, Vikas bhavan, Kasaragod Spawn is used for coirpith composting	1999	-	6000	
10	Mr.Surendran.K.M., Kannampalli madam, Kankol, Kannur Dt.	1998	580589	7200	5
11	Maya V.P., W/o Chandrasekharan, Kalyani Sadan, Kalliasseri, Kannur Dt.	1998	0497 780563	2400	1
12	Remani Rajendran and Jamuna Dharmpal, Aradhana Pallikkunnu (P.O), Kannur Dist	2005	04972 746460		10
13	Saju S. Chandran Suna Nivas, Vellikoth, Ajanoor, Kanhangad, Kasaragod Dt.	2004	0499 2266502		5
14	K.K. Unnikrishnan, Murali Nivas Edat (P.O.) Payyannur	2004	9447 758393		10
15	K. Unnikrishnan, Krishnalayam Embate, (P.O.) Pariyaram, Kannur	2005		2400	5
16	Smt Suma.T.C. Koothuparamba, Kannur Dist	2004		2400	10

Note: List of selected growers alone is given, which is not exhaustive.

7.2 Success stories

7.2.1 . During 1999 a group of seven women under the leadership of Mrs Sally started mushroom spawn production and mushroom cultivation at Udayapuram, after being trained from RARS, Pilicode. The unit was functioning at a moderate level with support from various agencies like District Panchayath, Grama Panchayath etc. Justin, a graduate in Microbiology from Rajapuram was interested in mushroom cultivation. He belongs to an agrarian family. It was in 2005 that Justin who got interested in popularization of mushroom production technology approached Dr. Govindan, Associate Professor (Microbiology), RARS, Pilicode. Based on the suggestions obtained from the Institute, he began to work with the above mushroom unit at Udayapuram in order to strengthen the Unit. As a result of the joint endeavor, they started the Microbiological and Bioinformative Advanced Research Center and strengthened mushroom spawn production as well as mushroom production and introduced value addition in the products. They decentralized the production of mushrooms by forming groups of unemployed youths in nearby villages and imparted training. Today the centre is producing 9600 bottles of mushroom spawn per year and 15 kg of mushroom per day against 6000 bottles /year and 2kg mushroom per day in 2001, benefitting 25 house holds. The centre provides direct employment to 12 people and the entire turn over has increased substantially.

7.2.2. Another success story

Sri Manoj of Kalliassery had burnt his fingers in a number of ventures like apiculture, sericulture and floriculture before being attracted to mushroom cultivation. He and his wife underwent mushroom production training at RARS, Piliocode in 1993. Armed with the knowledge and skill, they initiated farming a neighbourhood group of women and got

registered as Kalliassery Vanitha Mushroom Spawn Production Unit. The group started spawn production as well as edible mushroom production under the leadership of Mr. Manoj. With him providing the forward and backward linkages, the group soon increased the mushroom spawn production from 500 bottles / month in 2001 to 800 bottles/ month in 2005 and mushroom production from 2kg/ day to 5 kg/ day. Buoyed by the success of the initiative, Manoj soon formed nearly 15 groups of women in Kannur and adjoining districts. Today the 15 groups produce 30 kg of mushroom every day. At present nearly 75 households enjoy a substantial income through mushroom production. Manoj himself is earning Rs 10,000/ month by way of profits in a sustainable manner for the last 12 years.

7.3 Recycling of post mushroom substrates

Recently the term post mushroom substrate (PMS) is used to denote the spent mushroom substrate, which is the substrate left after cultivation of mushroom. PMS has many positive attributes. The material has been found to be good nutrient source for agriculture.

7.3.1 Spent mushroom substrate as organic fertiliser

Spent mushroom substrate can be used for compost production. This is a very common practice among the growers. They normally mix it with cow dung, dried plant litters and fill in an open pit. In the training programme, NADIP method or ICAR method has been suggested as a better way of preparing compost. The SMS can be used for this purpose. In farmer's field composting using SMS was found to be faster than other substrates.

7.3.2 SMS for vermicompost production

Trials conducted at Regional Agricultural Research Station, Pilicode indicated that SMS can be used for vermicompost production. The growth and multiplication of *Eudrillus* and *Eisenia* were found to be favoured by SMS incorporation. Trials were conducted on the effect of vermicompost on vegetables at Regional Agricultural Research Station, Pilicode and also in farmer's field. A demonstration unit on recycling SMS in vermicompost production is functioning in this research station.

7.3.3 SMS as animal feed

Normally the domestic cattle is fed with paddy straw as staple supplemented with concentrates like the cotton seed, groundnut cake etc. The high lignin content (2.5%) of the cell fibers reduces the accessibility of the cells to the digestive enzymes present in the animal gut. Spent mushroom substrate was found to be superior in terms of digestibility compared to commonly used cattle feed.

8. FARMER LEVEL INNOVATIONS

An attempt was made to document the farmer level innovations in the field of mushroom cultivation.

8.1. Use of non traditional substrates for mushroom production

In Ayurvedic hospitals and factories, manufacturing Ayurvedic medicines consume huge quantity of Ayurvedic herbs which are used for preparing 'kashayam'. After taking the extracts, huge quantity of solid waste materials are left out. Dr.Raghavan, Payyanur, an Ayurvedic physician tried this material for mushroom production. The yield obtained was equal to that from paddy straw. The result was published in a local newspaper.

8.2. Use of non traditional containers for mushroom spawn production

Normally empty glucose bottles or PP covers are used for spawn production. Mr. Chandrasekharan, Pappinisseri, Kannur District is using horlicks and liquor bottles for spawn production. He is also preparing liquid broth in such containers.

8.3. Use of rice bran and hull as substrate for mushroom spawn production

Normally paddy, wheat or sorghum grains are employed for spawn production. Considering the cost of materials, Mr. Chandrasekharan, Pappinisseri tried certain alternatives. He found that rice bran and hull can be used for spawn production. The yield obtained from such spawn was on par with to the yield obtained from spawn produced by traditional methods.

8.4. Spent mushroom substrate as animal feed

Normally the domestic cattle is fed with paddy straw. Digestibility of spent mushroom substrate gets improved due to mushroom cultivation. Smt Gracy, West Eleri, Kasaragod Dist. tried to include the SMS in the diet of cattle. The spent paddy straw obtained after first flush of *Pleurotus* was found better. Twenty five percent of the diet of one-month-old male calf was substituted by SMS. Initially it was not readily acceptable to the animal. But after mixing with a small quantity of jaggery, it was readily consumed. After two months of feeding, there was a weight gain of 15% over the animal fed without SMS.

9. SUGGESTIONS FOR FUTURE ACTIVITIES

In Kerala where per capita land available for cultivation is less, most of the vegetable requirements are met by importing from neighbouring states. People are well educated and well aware of the need for consuming nutritious health foods. In this context, promoting mushroom cultivation, which requires less land space needs top priority. Besides, mushroom cultivation can provide excellent job opportunities and help ease the unemployment problem among the ladies and youth of weaker sections of the society. Apart from the internal market, there exists vast export potentiality owing to the nearness of International Airports at Calicut and Mangalore.

In this context, it can be said with great pride that Regional Agricultural Research Station, Pilicode, has done excellent job to popularize this technology by acting as a nodal center of research, development activities and extension. However, a lot more are to be done in this field. A few suggestions are listed:

1. Development of improved strains of commercially important mushrooms and refinement of production technology to get sustainable yield.
2. Promoting domestic consumption of mushrooms through educational and promotional activities
3. Making available good quality spawn at cheaper rate near the door step of growers .
4. Quality control of mushroom spawn. There should be a regional centre to produce and distribute mother spawn to various spawn producers.
5. Encourage production of mushrooms and mushroom spawn in small units in rural areas.
6. Promoting collectivity in production and marketing to improve income to producers
7. Development of processing industry. Institutional finance to the entrepreneurs with nominal interest.
8. Providing electricity to the mushroom spawn producers at subsidized rate.
9. Strengthening support to the mushroom research, development and education programmes.

PART II

Practical Guide to Mushroom Production

1. ESTABLISHING MUSHROOM SPAWN PRODUCTION UNIT AT GROWERS' LEVEL

The acceleration of the movement of mushroom promotion in India rests on solving many of the operational problems of which the most important one is the lack of a mechanism and or an agency to ensure timely supply of the required quantum of spawn to the growers. Hence it is advised to establish a small scale spawn production unit to meet the local demand. In the first phase, mother spawn can be obtained from COA, Padnekkad and multiplied. From each bottle of mother spawn, 20-25 bottles of bed spawn can be prepared. Technical assistance and hands on trainings for serious growers interested in spawn production are being given at COA, Padnekkad. A successful mushroom grower cum spawn producer can go a step forward by producing pure culture and mother spawn after proper training.

Spawn is the 'seed' material for cultivating mushroom. It is the fungal growth maintained on grain based medium . Spawn production involves three stages viz. 1.Preparation of pure culture 2. Preparation of mother spawn and 3. Preparation of bed spawn.Tissue culture is used to bring the edible mushroom to pure culture. The first generation fungal culture is called the mother spawn . Normally , from the 'mother spawn', further 'spawn'(bed spawn) can be produced up to third or fourth generation . Continuous sub culturing may reduce efficiency of the spawn.

1.1. Pure culture technique

It needs high technical skill and knowledge of laboratory techniques. The procedure involves preparation of appropriate medium, sterilization, inoculation and subculturing.

Preparation of Potato dextrose agar (PDA) medium

The materials required for preparing PDA are Potatoes (200g)., Dextrose (20g), Agar (20g), Water (1 litre) and cotton wool (Non-absorbent).

Procedure

Wash 250g of Potatoes , remove the skin and cut into small pieces. Place the potatoes in 500 ml of water and cook for 20- 30 minutes .Remove potatoes and strain through muslin cloth and keep the broth as clear as possible. Melt 20g of agar in another 500 ml of water by heating over a water bath .Add glucose (20 g) to the filtered potato juice . Check the pH of the juice ; if needed, adjust the pH to 7.0 Add the molten agar while hot to potato juice, thoroughly mix and make up the volume to 1 litre the liquid medium in 100 ml quantities to 250 ml conical flasks or in clean small flat whisky bottles to a height of 5-10 cm. Plug the mouth of conical flasks or bottle with non-absorbent cotton , cover the plug with a piece of paper and tie the paper with thread. Sterilize (steam heating under pressure) the conical flasks or bottles containing the medium in a autoclave at 15 p.s. for 20 minutes to ensure complete sterilization. Let cool down to around 37°C. Place bottles in slanted position as to increase the surface area of the medium. PDA should come close to the neck but not touch the cotton plug.

Sterilizing media using an autoclave or pressure cooker

Autoclave or pressure cooker is used to sterilize media by using steam under pressure. An autoclave has a pressure and temperature gauge , steam outlet and safety valve while a pressure cooker is not provided with pressure and temperature gauges. Care should be taken while using autoclave. Certain guidelines to work with an autoclave are given below .

Autoclaves are available with varying capacity and specifications. Depending on the requirement and available budget, select the suitable one. Availability of electricity, and its unit cost also should be considered while choosing the model (which work on electricity or gas). Pour water to a level well above the heating coil and place a tripod stand inside the autoclave. Place the inner (perforated) container over the stand. See that the water level just touches the base of the performed container. Carefully arrange the bottles or conical flasks in the container of the autoclave. Bottles or flasks with media may be arranged one above the other without tilting. Close the lid, tighten the bolts and keep open the steam outlet. Switch on the main (for electrically heated autoclave) or heat with a gas burner. Note the steam coming out of steam outlet with a hissing noise. Now, close the steam outlet before seeing the steam coming out. Maintain the pressure at 15 p.s.i for 20 minutes for sterilizing media or 1-1.5 hours for spawn. Switch off the main after sterilization. Slightly open the outlet and allow the steam to escape. Avoid sudden opening of steam outlet. After cooling, open the lid and remove the materials from the autoclave.

Instead of autoclave , pressure cooker can also be used for sterilization. Use pressure cooker of 22 or 24 litre capacity and place the perforated stand in the bottom of the cooker. Pour water to a height of about 10 cm for long time sterilization (2 hours) and about a height of 3 to 4 cm for short time sterilization (15 -30 minutes). Place the materials in the cooker, keep the lid in position and open the steam outlet. Heat the pressure cooker and when the steam comes out with hissing noise place the cooker weight. Note the time when the first whistling sound is heard

Keep the burner in low flame and continue heating the cooker for the required time. Put off the flame after the required time and allow the steam to escape by itself. Open the lid after complete exhaustion of steam and then remove the materials

Isolation of the mushroom fungus from fruit body

Take clean dry petri plates in copper jackets and keep them in hot air oven at 180 ° c for 2 hours for sterilization. Take out the petriplates after cooling and bring to the inoculation room. Melt the medium on water bath or by steaming in an autoclave/pressure cooker. When the medium is about to solidify (45^0C), pour the medium in 20 ml quantities (approximately) in each petri plate by gently opening the petri plates on one side. Quickly close the plate after pouring medium . Allow the medium to solidify in plates. Now, the plates with the medium are ready for use.

Collect healthy, fresh mushroom which is not too mature not too young and is growing far from any contamination. Swiftly swab the mushroom with 80 per cent ethyl alcohol for surface disinfection. Cut the mushroom with a sterile blade at the junction of cap and stalk.

Remove a small bit of tissue from the centre with a sterilized forceps. Keep about 10 ml of 2.0 % sodium hypo chlorite or 0.1 % mercuric chloride in sterilized petri plate. Also keep about 20 ml of sterile distilled water in two more sterile petri plates. Wash the bit of tissue for one minute in 2.0 % sodium hypo chlorite or 30 seconds in 0.1 % mercuric chloride. Subsequently wash the tissue serially in sterile distilled water 5- 6 times to free the sodium hypo chlorite or mercuric chloride. (Caution: Mercuric chloride is deadly poisonous).

Place the washed tissue on the centre of the petri plate containing PDA medium. In this way prepare 4 to 5 plates. Incubate the petri plates at room temperature for 7 days outside the culture room. Observe the pure white growth of mycelia radiating from the centre of the medium.

Transfer a small bit of pure growth of mushroom fungus from the petri plate into PDA slant with the help of sterile inoculation needle (to be done in culture room).. The fungus will grow on the surface of PDA slants. Store them as stock culture at room temperature or in a refrigerator. Contaminated plates are to be discarded

Multiplication of Culture from PDA to PDA

Because of the high risk of contamination in tissue culture, it is recommended that tissue culture be done in only a few bottles of PDA since . Then, several bottles of PDA can be prepared from the extremely pure mycelium.

Clean the inoculation room and all necessary tools, inside and outside the laminar flow cabinet with alcohol. Transfer PDA bottles and / test tube slants and other necessary tools into the chamber. Place all cleaned materials inside laminar flow. Turn on UV lamp and laminar flow. After 10-15 minutes, turn off UV lamp but leave laminar flow for the duration of the operation. With the needle, cut a small piece (5 mm x 5 mm) of mycelium on PDA. Make sure that the PDA is not contaminated. Flame around the mouth of the new PDA bottle/ test tube. Using other fingers, remove cotton plug of PDA bottle in front of flame to secure against contamination. Insert the needle in the bottle and inoculate by placing small piece of PDA mycelium on the middle of the PDA's surface. Make sure the mycelium PDA does not touch anything before entering the PDA bottle. Close bottle immediately near the flame with cotton plug .The bottom of the bottle should always be lower than the mouth of the bottle and the mouth of the bottle should remain near the flame at all times. Label bottles and indicate date, type of mushroom, etc.

From the time of inoculation to full growth (Whether from tissue culture or PDA to PDA) mycelium will take about 7-14 days,depending on species. Keep PDA bottles with mycelium on clean shelf. Everyday, check growth rate and contamination by other fungi in the bottle . After mycelium covers whole PDA medium, keep mature mycelium in cool place or in the refrigerator in the vegetables section. Check for contamination and immediately transfer them for cleaning.

1.2. Mother spawn preparation

This is also a highly specialized part of mushroom production . Growers should know how to select and buy good quality spawn from various suppliers. They should also know all steps involved in mushroom cultivation to allow future expansion of their mushroom farm.

Method of preparation

Various types of grains like Sorghum, millet, wheat, paddy etc can be used for spawn production. Select good quality well filled bold grains free from pests and moulds. Put the grains in water to remove chaffy and damaged grains. Steam for 30-45 minutes in an ordinary vessel to soften and half cook the grains. Test the cooked grains by gently pressing them between fingers. Grains should slightly break; should not be sticky. Remove the half cooked grains, drain out water and spread over Hessian cloth evenly to allow excess water to evaporate .Approximate time required is 60 minutes. Mix thoroughly 20 g of calcium carbonate for every kg of grains. Fill the grains in glucose drip bottles (which are previously cleaned with soap water, rinsed with fresh water and sun dried) up to ¾ the height (300 g/ bottle). Tightly plug the mouth of the bottles with non- absorbent cotton. Cover the cotton plug with the paper and tie it around the neck of the bottle using twine. Keep the bottles in an autoclave or pressure cooker and Sterilize the bottles with grains at 20 p.s.i. for 2 hours. After cooling, the bottles are ready for use

Transfer bottles to a clean and cool place. Clean laminar flow chamber using alcohol. Transfer PDA and sterilized bottles containing grains into the laminar flow chamber. Light UV lamp for 10 - 15 minutes before starting. Place needle in alcohol. Turn off UV. Clean both hands with alcohol and insert hands into the chamber.

Using 2 fingers, take out inoculation needle, pass through flame as to burn alcohol, and disinfect needle. Make sure the needle turns red. After the needle cooled down to normal state, use needle to cut small square (5mm x 5mm) discs of PDA with mycelium (white colour) from PDA slants or petri plates . Close the petri plate or test tube immediately.

Keep the mouth and shoulder of the grain bottle near the flame. Spawn bottle should be opened only near the flame to avoid contamination. Insert needle and inoculate sorghum seeds with PDA mycelium by placing small square piece in the middle of the bottle. Make sure the PDA mycelium does not touch anything before entering the sorghum seeds bottle. The mouth of the bottle should be near the flame. Do not touch mouth of bottle with piece of PDA. From one Petri dish containing good growth of the mushroom fungus about 10 bottles could be inoculated. Close bottle immediately. Place paper over cotton and tie with plastic or cotton thread or rubber band. Label inoculated bottles writing: Date, Spawn no., ref., and inoculation time. Incubate the spawn bottles at room temperature and observe the growing mycelium. It takes about 15 - 18 days to get full- growth of white mycelium covering the entire bottle. Allow the spawn to mature 4 to 5 days more. Now the mother spawn is ready for use. Keep mature spawn in a cool place or in the vegetable compartment of the refrigerator. Check for contamination regularly and remove contaminated bottles to cleaning site. A loss of about 3% is to be expected.

1.3. Multiplication of bed spawn from mother spawn

Growers need specialized training for multiplication of bed spawn from mother spawn. They can collect mother spawn from reliable source and use it for multiplication and sale. This activity can be taken up as a separate enterprise also. From a single mother spawn 20-25 bottles could be prepared. Always use well grown spawn .

Bed spawn is prepared in glucose drip bottles or in polypropylene covers. Grains like Sorghum, millet, wheat , Paddy etc can be used for spawn production. Substrate preparation, filling bottles, and sterilization of bottles containing grains are done in the same way as described above. Transfer the sterilized bottles and mother spawn to the inoculation chamber. Use a spirit lamp or Bunsen burner. Hold the spawn bottle in left hand and open the plug with right hand by keeping the mouth of the bottle near the flame.With the help of a hooked sterilized 5 mm iron rod or inoculation needle stir the spawn to separate individual grains with the fungal growth. Open the sterilized bottle with grains in the same way holding the cotton plug in right hand. Transfer about 10 g of sorghum/ paddy grains with the fungus to the new bottle. Heat the mouth of the inoculated bottle and quickly close with the same cotton plug. All the above steps should be done near the flame to avoid contamination. Incubate the spawn bottles at room temperature . In about 15 days time full growth could be seen. Use 18 to 20 days old spawn for bed preparation. Spawn when stored under normal room temperature, can be used up to a maximum period of 30 days .Temperature below 15^{0}C and above 30^{0}C is not very favourable for growth.

2. CULTIVATION OF OYSTER MUSHROOM

Kerala is ideal for the cultivation of oyster mushroom. Cultivation is done in polythene bags (35x45 cm). Polythene bags are helpful to retain moisture content and also protect from air borne weed moulds and flies. Oyster mushroom cultivation involves simple and easy to adapt technology . Agricultural wastes or byproducts of agriculture /industry like paddy straw , paper waste , sugarcane bagasse, cotton waste , hulled maize cobs, etc, can be used as substrates for cultivation of oyster mushroom. For successful mushroom cultivation, special rooms or thatched sheds are required.

Spawn running room

Spawn running room is one where the beds are kept for proliferation of mushroom fungus mycelium in the bed. An ordinary room or a thatched shed can be used as a spawn running room. Multi-tier racks can be provided in the room to have more space. The beds may be arranged in one or two rows in each tier. This room does not require light but needs ventilation. Temperature in the room should be between 24 and 28^{0}C and should not be more than 30^{0}C.

Cropping room

Cropping room is one where we keep the opened beds after completion of spawn running for production of mushrooms. This room requires relatively cooler temperature than spawn running room. The temperature should be between 23 and 25^{0}C. In plains, a thatched shed or sheds with asbestos roofing in hilly areas will serve the purpose.

Cropping room should have a door , ventilators (fly proof) flase roofing and racks to accommodate mushroom beds. In plains , the floor of the shed may be filled with sand to a height of 30 cm. All the sides should be closed with thatching material. The inner sides should be lined with hanging gunny. The floor and the gunny should be wetted with water twice a day. This will keep the room cooler besides increasing humidity. Providing false

roofing in hotter area will help to reduce the temperature further. Thatched shed with Palmyra leaf roofing will also be useful. Minimum of 4-6 ventilators with fly proof should be provided.

The length and breadth of the shed may be modified conveniently. The shed may be laid in east west to avoid the direct of sun and to reduce the temperature inside cropping room. Cropping room should have diffused light and good ventilation.

Approximate space requirement of cropping and spawn running rooms

Mushroom production (kg/day)	Spawn running room	Cropping room	No. of beds/day	No. of racks (80 beds/rack)
1 Kg	8 m^2(4 x 2m)	8 m^2 (4 x 2m)	4	2
5 Kg	40.5 m^2 (13.5 x 3m)	40.5 m^2 (13.5 x 3m)	20	10
20 Kg	162 m^2 (27 x 6 m)	162 m^2 (27 x 6 m)	80	40

* Size of the door : 2,0 x 0.76 m No. of ventilator : 2 to 12 (according to size of shed)
Size of the ventilator : 0.60 x 0.30 m

Substrate preparation

Cut the paddy straw to about 3-5 cm using the chaff cutter. Soak the cut straw in potable water contained in a cement trough or G.I. drum for about 4-6 hours. Remove the soaked straw and keep in wire basket for 30 minutes to drain water .Boil water in a G.I. drum and keep the pre-soaked paddy straw immersed in boiling water for about 30 minutes or steam the straw in an autoclave for 30 minutes. By this process the micro-organisms ; insects, larvae and eggs of insects are destroyed. Tie around the mouth of the vessel with Hessian cloth and keep the vessel in tilted position to drain the water. Remove the straw from the vessel and drain water by keeping in wire baskets . Spread the straw on a clean hessian cloth previously soaked in fungicide solution.(5 g Bavistin + 10 g Dithane M45 in 10 l water) or 0.1 % potassium permanganate solution. Allow the straw to loose excess moisture. The above step should be done in a clean room.

Paddy straw should contain the optimum moisture . Excess moisture will lead to bacterial contamination and rotting of straw . Low moisture will not permit spawn running. If paddy straw is squeezed in hand, water should not drip down. 1 kg of dry paddy straw when processed will approximately weigh 5 kg. Now the substrate is ready for bed preparation. Each cylindrical bed requires 2.5 kg of wet straw approximately equivalent to 0.5 kg of dry straw.

Filling the pasteurized straw in polythene bags

Take polythene bag of 60 x 30 cm size. Put two holes of 1 cm diameter in the centre of the bag on each side. Tie the bottom of the bag with jute thread. This provides flat circular bottom for the bed when prepared. Clean a plastic tray with dettol solution (1 ml dettol in

100 ml of water). Wash hands also with dettol solution. Disinfect the hooked iron rod with dettol. Swab the surface of the spawn bottle also with the above solution. Remove the cotton plug and insert the hooked iron rod into the spawn bottle and remove the spawn. Collect the spawn in the disinfected tray and break the solid spawns with fingers to individual grains. Divide the spawn (300 g) in to two halves. Again apportion one half of spawn into four equal parts. Spread the straw bits uniformly in the bottom of polythene bags to a height of about 5 cm. Sprinkle one portion of spawn (out of four portions) uniformly over the entire surface of the straw. Spread the second layer of straw to a height of 10 cm and sprinkle second portion of spawn over the surface uniformly. When every layer of straw is put., gently jerk the polythene bag for uniform pack of straw. Spread third layer of straw to a height of 10 cm and sprinkle third portion of spawn .Form the fourth layer (10 cm) and sprinkle last portion of spawn. Finally, cover the fourth layer of spawn with straw, bits to a height of 5 cm and tie to the bag with jute thread. Straw layers should not be pressed hard by fingers. Now, the cylindrical bed is ready for keeping in spawn running room. All the above steps (bed preparation) should be done in a clean room.

Spawn running and opening of beds

Keep the cylindrical beds in a spawn running room provided with racks.Observe daily the growth of the fungus. Fungus grows as a white thread and permeates the entire bed. Spawn running will be completed in about 15 to 20 days.Open the polythene bag by cutting with sterile blade on 16th day of spawning for white oyster mushroom and on 21st day for grey oyster mushroom. The bed will be intact after removing the polythene bag. In some cases mushrooms may come out piercing through the polythene bag even before the specified time. In that case remove polythene bag immediately .

Cropping

Transfer the opened beds to cropping room. For about 2 days there is no need to spray water on beds. Afterwards, spray water on the beds every day in the morning and evening using a sprayer. Observe the appearance of mushroom buds (pin heads) on the third or fourth day of opening the beds. Full grown mushroom develops within three to four days of appearance of pin heads. Pluck full grown mushrooms with roots early in the morning before spraying water on beds. After completing the first harvest , scrap and remove about 1-2 cm deep layer of straw from the entire surface of the bed. Continue spraying water twice a day. Second crop of mushroom appears in another week.Two to three crops of mushrooms can be had in this way. The entire cropping will be over in about 35-40 days for white oyster mushroom and in 40-45 days for grey oyster mushroom. Harvested mushrooms should not be washed in water

Packing and storage

After harvesting , remove straw bits and root portions. Pack the cleaned mushrooms in perforated polythene bags. Small packing of 250 g fresh mushroom will be ideal. Normally mushrooms should be used on the same day of harvest . Normal shelf life is about 12-16 hours at room temperature. But mushrooms can be stored for about 3 days in refrigerator.

Long time storage is possible by various methods like blanching and drying, canning, freezing and drying, etc. However drying is the simplest method.

Blanching and drying

Wrap the fresh mushrooms in a clean white cloth. Immerse in boiling water for 4-5 minutes or steam for 3 minutes. Immerse in cold water immediately. Then drain the water by spreading on perforated containers. Dry the blanched mushrooms under sun for about 2-3 days or at 50°C in hot air oven for one day. Keep the dried mushrooms in polythene bags and seal them air tight to prevent reabsorption of moisture from atmosphere. In this way mushrooms can be stored for about a month . Whenever it is needed the dried mushrooms may be immersed in lukewarm water for a minutes and used.

Pests, weed moulds and diseases

Economic production of mushroom suffers due to the damage by Weed moulds (contaminants) in spawn Weed moulds (competitors) in beds ,pests and diseases..

Weed moulds (contaminants) in spawn

They appear as black or green growth within five days after inoculation inside spawn bottle instead of white threads of oyster mushroom.

Proper precautions are to be taken while preparing spawn. Always prepare the spawn in a clean room. Avoid rooms with high temperature (> 30°C), dustly rooms and un sterilized materials. Ensure proper cooking and correct proportion of mixing of calcium carbonate to encourage good growth of spawn. Introduce sufficient inoculum into spawn bottles. Avoid loose plugging of spawn bottles .Maintain sterile condition in culture room. Avoid frequent opening of culture room. Always keep the room free of dust and microorganisms by sambing all the surfaces exposed to air with 1% dettol or any other antiseptic solution. Switch of UV lamp for 20-30 minutes before using the room. Once in a month or two (or as required) fumigate the culture room. For this, take 10 g of potassium permanganate in a beaker and add 20 ml of formalin. Keep the beaker in culture room (for a room of 1.5 M x 1.5 M x 2.2 M) and close the door. Fumes generated will circulate inside the room and kill at the microorganisms. Keep the room closed for 24 hours. Use the room after 24 -36 hours to avoid irritation to eyes. Take adequate precautions during inoculation in culture room.Close the door quickly after entering the room. Always keep the door closed. Do not indulge in dialogue when inside. Carefully open the spawn bottle or test tube by keeping very near the flame and quickly heat the mouth of the bottle/test tube. All the materials and accessories used for inoculation should be sterile (should be heated well over the flame). Quickly transfer the inoculum. Ensure proper sterilization of spawn bottles

Weed moulds in beds

Normally the beds are contaminated, either before or after opening with moulds like green moulds (Aspergillus penicillium and Trichoderma) olive green mould *(Chaetomium* sp.), inky caps (Coprinus) and *Sclerotium* sp. Due to improper boiling of straw or use of old or spoiled straw and or unhygienic conditions in the area of bed preparation.

By taking proper precautions during various stages of cultivation, these problems can be avoided. Boil the straw properly as described earlier. Do not use the water used for soaking the straw for boiling. Always use fresh water for boiling straw.Always prepare beds indoor. Use disinfected gunny cloth and room. Maintain optimum moisture in straw. If mould growth is noticed in small patches on the beds , carefully cut out the affected area and swab the area with 0.05% Bavistin or 0.1 % Dithane M 45. Burn the removed patch of mould. Dispose the contaminated beds by deeply burying them in a distant place or by carefully burning them . This avoids further spread of the moulds. In case of frequent contamination in beds kept either in spawn running room or cropping room, remove all the beds and fungicide the room by spraying 6 ml of dichlorvos + 200 ml of formalin in 10 litres of water. Close all doors and ventilators for 24 hours. Use the room after 24-48 hours.

Pests

Mushroom fly (Phorid) is one of the common pests in beds. It enters through the vents and lays large number of eggs. The larvae feed on mycelium of the mushroom fungus and form a clear wet zone around the vent. Because of active feeding of larvae and movement of flies inside the bed, mould and bacterial contamination increase. Straw and spawn tend to rot due to bacterial contamination .

Management practies: Spray the room and surrounding area with malathion (1 ml/ litre of water) . Paddy straw can also be sprayed with this insecticide at the time of bed preparation.

3. CULTIVATION OF MILKY MUSHROOM (*CALOCYBE INDICA*)

The mushroom *Calocybe indica* identified by Purkayastha and Chandra (1974) was a wild edible mushroom growing in West Bengal. It was first cultivated by Purkayastha and Nayak (1979). Now in Kerala many growers prefer to grow Calocybe due to its good keeping quality (20 days in refrigerator in 100 gauze pp bags with 8-16 holes), pure milky white colour and easy method of cultivation with biological efficiency comparable to oyster mush room.

Spawn of Calocybe and oyster mushroom is prepared by same procedure. The spawn run of Calocybe will be completed in 10-12 days. From each bottle of mother culture 25 additional spawn bottles can be multiplied.

A wide range of cellulosic substrates like paddy straw, maize stalks, sorghum stalks pearl millet stalks, palmarosa grass, vetiver grass, sugarcane bagasse, soybean hay, ground nut haulms are used for the cultivation of Calocybe. In Kerala paddy straw is commonly used.

Chopped paddy straw bits of 3-5 cm in length are soaked in water for 12-14 h. After draining the excess water , the straw bits are pasteurized by a) hot water treatment or b) steam pasteurization or 3) chemical treatment.

In hot water treatment boil water in a tank. Submerge straw filled in gunny bags in hot water at 80-90°C for 40-60 min. Sometimes , steam treatment of substrate for 1 h or chemical treatment with carbendazim 75 ppm + formalin 500 ppm (soaked for 16 h) may be

followed. Comparatively hot water or steam treatment is safe and best. Commercial growers mostly follow chemical sterilization.

After substrate treatment, the substrate is cooled on a wire mesh to room temperature and remove excess moisture and used for bed preparation. At the time of bed preparation the substrate should contain around 60 per cent moisture. It can be tested by squeeze method.

Polythene bags of 35x45cm size are used for mushroom bed preparation. It can hold 2.5 to 3.0 kg of wet substrate. Once cooled, the straw is filled in bags and spawned layer wise simultaneously. The straw is filled in polythene bags by pressing uniformly and the spawn is seeded @ 1-2% of the substrate. Spawning is done by surface spawning or thorough spawning or layer spawning.

In surface spawning, pasteurized substrate is filled in bags and spawn is broadcast on the top and ruffled. This process is followed when bags with substrate are sterilised in autoclave or steam sterilizer.

Layer spawning is adopted when hot water or steam pasteurization is done. In this method the substrate is put in layers (about 8-10 cm) and each layer is followed by a layer of spawn. This process is continued till the whole bag is filled up in 3-4 layers.

The mouth of polythene bag is sealed with the help of rubber bands. In order to provide aeration, holes (2mm in diam) are made in the polythene bags. The beds are then incubated for mycelial growth. The phase of mushroom mycelium growth on the substrate is called spawn running stage. Fresh air requirement at this stage is negligible. High carbon dioxide favours growth and the room should be kept dark. A temperature range of 25-35^{0}C and humidity around 80% should be maintained. Constant inspection must be carried out and any contaminated bags must be discarded. Spawn run will be completed in 14-18 days. After completion of mycelial growth, casing is to be done. Casing is the process of putting a layer of pasteurized soil on the substrate to induce fructification in addition to giving physical support to the fruiting bodies.

Casing material is chemically pasteurized by drenching it with formaldehyde solution (5%), two weeks before casing so that at the time of casing it is free from formalin. However steam pasteurization is most effective. For casing , garden soil mixed with sand and chalk powder (4-6% to bring the pH to 7-7.5%) is used. Casing material (moist) is filled in trays with 2-3 inches legs and stacked inside pasteurisation chamber. Pasteurisation is done at 65 ^{0}C for 2 hrs. It can also be sterilized in an autoclave at 15 lb pressure for 30 min.

The fully colonized bags are shifted to the cropping room and opened. The plastic is rolled downwards and the substrate levelled. A layer of cool pasteurized soil (2-3 cm thick) is uniformly spread on the top of the substrate. If the height of the bed is around 50 cm, then the cylindrical beds are cut horizontally into two equal halves. Over the each half bed casing soil is applied as described above.

Beds after casing are kept in the cropping room and sprayed regularly with water to maintain 50-60 per cent moisture level in the casing medium. After 3-4 days of casing the

mycelial strands could be seen on the casing material. Pin heads appear 15-20 days after casing. During this phase a temperature of 28-35 ^{0}C (optimum 30-32^{0}C), R.H. of 80-90% and good cross ventilation must be maintained. Watering must be carried out with a sprayer but care must be taken to avoid over watering. Light (diffused or fluorescent tubes) can be used on 12 hrs cycle. If the stalks tend to become long with a small pileus, fresh air must be introduced. It takes 8-10 days for the maturation of fruit initials. The first harvest can be made in 6-8 days after pinhead formation . Mushrooms should be harvested before they start shedding the spores. Single sporophore (button) mushroom weighs 55 to 60 g generally. Rarely single sporophore weighing maximum of 472 g/button has been obtained. After obtaining the first harvest the casing medium is gently ruffled, slightly compacted back and sprayed regularly with water. Second and third harvest will be obtained within 45-50 days of bed preparation. Then the beds are removed. With each bottle of spawn 2-3 cylindrical beds can be prepared. Usually 800 to 1250 g of mushroom is obtained from one kg of dry substrate.

4. BUDGET ESTIMATE FOR A SMALL SCALE MUSHROOM SPAWN PRODUCTION (GRAMA PANCHAYAT LEVEL)

Capacity :	:	16 packets daily.

A. Capital investment

Building :	:	Make use of the available building
Culture room	:	5000 U.V.
lamp	:	1000 Tube lights/ electricity connection
	:	1500
Pressure cooker (large) (2 Nos.)	:	5000
LPG Cylinder, stove, burner	:	4000
Table	:	3000
Racks	:	2000
Stove	:	1000
Vessels, others	:	2000
Inoculation chamber	:	5000
Refrigerator	:	10000
Total	:	40,000

B. Working capital

1. Grains/maize (1350 kg.)	:	9450
2. Calcium carbonate (68kg.)	:	8100
3. P.P. cover/bottles (45)	:	3300
4. Cotton (60 kg)	:	3720
5. Gas stove	:	3000
6. Electricity	:	1500
7. Mother spawn (225)	:	3375
8. Wages for labourers	:	22,500
9. Others	:	1000
Total	:	55945

C. Depreciation: (of Capital investment)

	Percentage	Initial cost	Annual depreciation
Pressure cooker Burner Stove	10	6000	600
Vessels U .V.	50	1000	500
Tube light	100	1500	1500
Total Depreciation			2600

D. Cost of Production

1. Running expense	:	55945
2. Interest of depreciation (at the rate of 12%)	:	4800
3. Depreciation	:	2600
Total	:	63345

E. Income

4800 spawn bottles sold at the rate of Rs. 15,	:	72,000
Total	:	8655

5. BUDGET ESTIMATE FOR LARGE SCALE MUSHROOM SPAWN PRODUCTION

(Block/District level)

Capacity : 15,000 packets per year

A. Capital investment:

Building and other facilities	1,25,000
Autoclave	1,50,000
U .V. lamp	1000
Tube light	1000
Water/ Electricity connections	3000
Pressure cooker (large) (1 No.)	2500
LPG Cylinder, Stove, Burner	5000
Table	5000
Racks	4000
Stove	1000
Vessels, others	3000
Inoculation chamber	10000
Fridge	10000
Total	3,20,500

B. Working capital

1. Grains/ maize (4500 kg.)	:	35500
2. Calcium carbonate (225 kg.)	:	11250
3. P.P. cover/ bottles (150)	:	11000
4. Cotton (200 kg)		12375
5. Gas stove		3000
6 Electricity		3000
7. Mother spawn (600)		9000
8. Wages for labourers (2 ladies/300 days)	:	45000
9. Plastic bucket	:	100
10. Others		2000
Total	:	1,32,000

C. Depreciation: (of Capital investment)

	Percentage	Initial cost	Annual depreciation
Autoclave Pressure cooker Burner Stove	10	162500	16250
Vessels U .V.	50	3000	1500
Tube light	100	2000	2000
Total Depreciation			19750

D Cost of Production

1. Running expense	:	1,32,000
2. Interest of depreciation (at the rate of 12%)	:	38,450
3. Depreciation	:	19,750
Total	:	1,90,200

E. Income

15000 spawn bottles sold at the rate of Rs. 15	:	2,25,000
Total	:	34,800

6. BUDGET ESTIMATE FOR ESTABLISHING MUSHROOM PRODUCTION UNIT

A. Capital investment

Sl No	Items	Production(5 kg daily)	Production(20 kg daily)
1	Shed	10,000	20,000
2	Racks etc		
3	Sprayer	600	600
4	G .I. Drum	600	1,200
5	Aluminium	1,000	2,000
6	Stove, others	500	1,000
	Total	12,700	24,800

B. Working capital

	Weight	Rate	Weight	Rate
Straw	2,100 kg	3,200	10,500 kg	12,800
Polythene cover(Cultivation)	35 Kg	2,625	2,625 kg	10,500
Polythene cover (Packing) Pestisides, Detol etc		200		500
Wage for labour	One female labourer/day	2,250	Two female labourers/day	4,500
Energy		500		2,000
Spawn	700 bottle	10,500	10500	42,000
Total		39,525		1,12,800

C. Depreciation

Shed, Rack	2000/-	4000/-
Spreyar (10%)	60/-	120/-
Drum, Vatta(50%)	800/-	1600/-
Total	2,800/-	5,700/-

D. Capital Investment

Working Capital	39,525/-	1,12,800/-
Depreciation	2,860/-	5,720/-
Interest of Capital (@ 12%)	1,524/-	2,976/-
Total Investment	43,900/-	1,21,500/-

E. Income

Sl. No	Items	Production (5 kg daily)	Production (20 kg daily)
1	Total Investment	43900	1,21,500/-
2	Income from Mushroom Sale	90000	360000/-

For calculation , B.E of 70% ., and a market value of Rs 60 per kg has been taken. In kerala present market vlue of fresh mushroom is Rs 100 per kg.

REFERENCES

Bhavani Devi, S and M.C. Nair 1991. In: *Fifteen years of mushroom research in Kerala Agricultural University* (Eds) M. Aravindakshan, M.C. Nair, and Gokulapalan 1991. Kerala Agricultural University, Vellanikkara PP: 2-4 Purkayastha and Chandra (1974) A new species of edible mushroom from India. Trans. British Myc. Soc. 62:415.

Jothimani, S. 1994. Organic farming in coconut. *Indian Coconut J.* 25:48-49

Purkayastha and Nayak (1979) A new method of cultivation of *Calocybe indica. Taiwan mushroom* 3:14

Rajarathnam, S, Shashirekha M N, and Bano C 1992. Biopotentials of the Basidiomacromycetes. *Adv.Applied Microbiol.* 37: 233-361.

Ramamoorthy, V., Meena, M., Muthusamy, M., Seetharaman K. and Alice D. 1999. Composting coirpith using lignocellulolytic fungi for the management of root rot of black gram. *Mushroom. Res.* 8: 13-17

Recent advances in the cultivation technology of edible mushrooms, 1978. National Research Centre for mushroom., Solan, India.

Theradimani, M. and T. Marimuthu 1993. Role of native flora in decomposing coir pith. *Indian. Coconut J.*61:5-7.