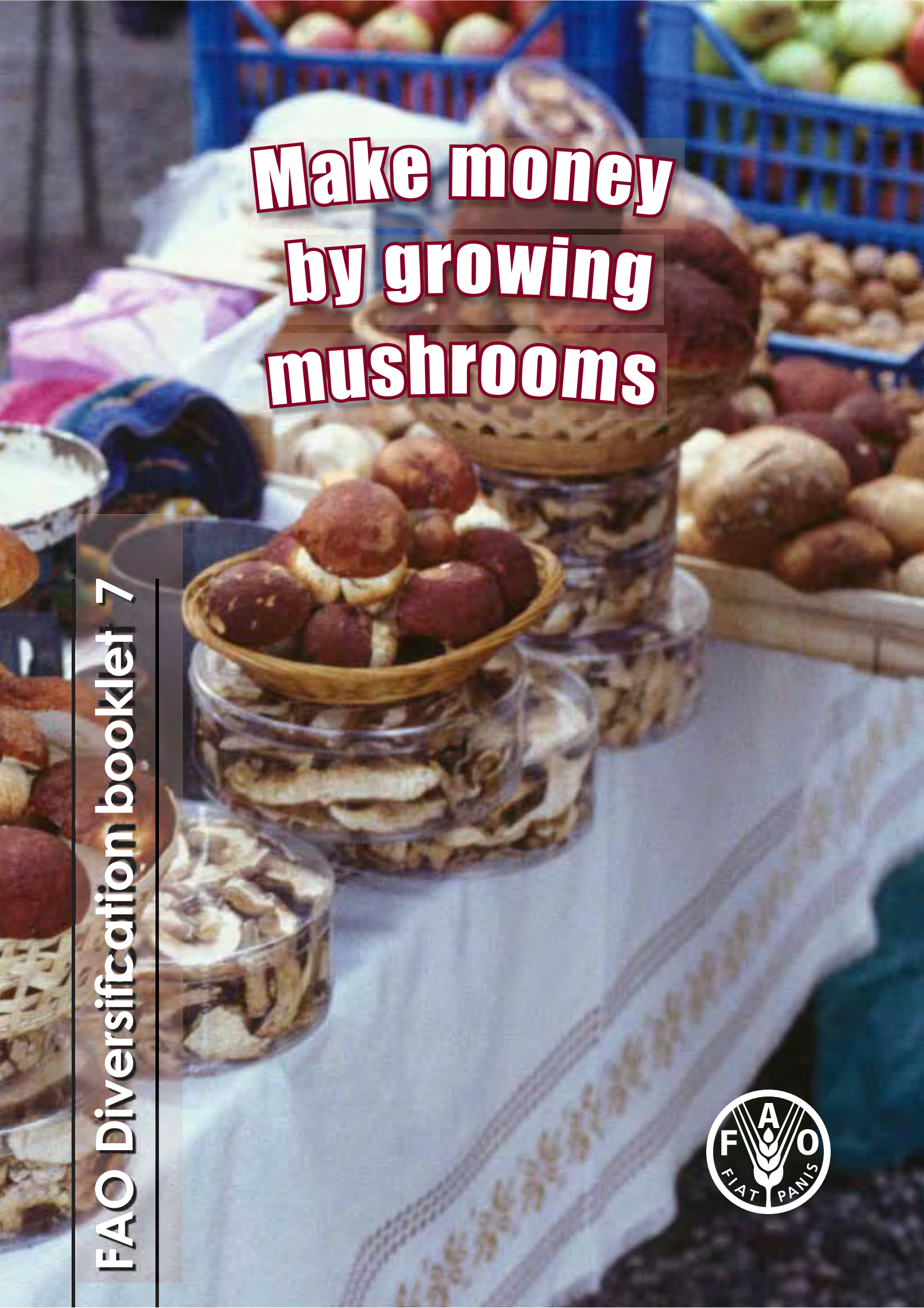

Make money by growing mushrooms

FAO Diversification booklet 7

Diversification booklet number 7

Make money by growing mushrooms

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Preface

The purpose of the FAO Diversification booklets is to raise awareness and provide decision support information about opportunities at farm and local community level to increase the incomes of small-scale farmers.

Each booklet focuses on a farm or non-farm enterprise that can be integrated into small farms to increase incomes and enhance livelihoods. The enterprises profiled in the FAO Diversification booklets selected are suitable for smallholder farmers in terms of resource requirements, additional costs, exposure to risk and complexity. The products or services generated by the enterprises are suitable for meeting demand on a growing, or already strong, local market and are not dependent on an export market.

The main target audience for these booklets are people and organizations that provide advisory, business and technical support services to resource-poor small-scale farmers and local communities in low- and middle-income countries. It is hoped that enough information is given to help these support service providers to consider new income-generating opportunities and how these might enable small-scale farmers to take action. What are the potential benefits? What are farmer requirements and constraints? What are critical 'success factors'?

The FAO Diversification booklets are also targeted to policy-makers and programme managers in government and non-governmental organizations. What actions might policy-makers take to create enabling environments for small-scale farmers to diversify into new income-generating activities?

The FAO Diversification booklets are not intended to be technical 'how to do it' guidelines. Readers will need to seek more information or technical support, so as to provide farmer advisory and support activities relating to the introduction of new income-generating activities. To assist in this respect,

each booklet identifies additional sources of information, technical support and website addresses.

A CD has been prepared with a full series of FAO Diversification booklets and relevant FAO technical guides, together with complementary guides on market research, financing, business planning, etc. Copies of the CD are available on request from FAO. FAO Diversification booklets can also be downloaded from the FAO Internet site.

If you find this booklet of value, we would like to hear from you. Tell your colleagues and friends about it. FAO would welcome suggestions about possible changes for enhancing our next edition or regarding relevant topics for other booklets. By sharing your views and ideas with us we can provide better services to you.

Acknowledgements

Gratitude is owed to Divine N. Njie, Agro-industries Officer and Alexandra Röttger, Agribusiness Economist, Rural Infrastructure and Agro-industries Division (AGS), FAO, for providing input, reviews and support to the various drafts of this booklet. Thanks are also owed to Siobhan Kelly, Agribusiness and Enterprise Development Officer (AGS), FAO, for carefully reviewing the final draft version of this booklet.

Acknowledgements for the series

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Introduction

There are hundreds of identified species of fungi which, since time immemorial, have made a significant global contribution to human food and medicine. Some estimate that the total number of useful fungi – defined as having edible and medicinal value – are over 2 300 species. Although this contribution has historically been made through the collection of wild edible fungi, there is a growing interest in cultivation to supplement, or replace, wild harvest. This is a result of the increased recognition of the nutritional value of many species, coupled with the realization of the income generating potential of fungi through trade. In addition, where knowledge about wild fungi is not passed on within families or throughout communities, people have become more reluctant to wild harvest and prefer to cultivate mushrooms instead.

Cultivated mushrooms have now become popular all over the world. There are over 200 genera of macrofungi which contain species of use to people. Twelve species are commonly grown for food and/or medicinal purposes, across tropical and temperate zones, including the Common mushroom *(Agaricus)*, Shiitake *(Lentinus)*, Oyster *(Pleurotus)*, Straw *(Volvariella)*, Lion's Head or Pom Pom *(Hericium)*, Ear *(Auricularis)*, Ganoderma *(Reishi)*, Maitake *(Grifola frondosa)*, Winter *(Flammulina)*, White jelly *(Tremella)*, Nameko *(Pholiota)*, and Shaggy Mane mushrooms *(Coprinus)*. Commercial markets are dominated by *Agaricus bisporus*, *Lentinula edodes* and *Pleurotus* spp, which represent three quarters of mushrooms cultivated globally.

Contribution to livelihoods

Mushroom cultivation can help reduce vulnerability to poverty and strengthens livelihoods through the generation of a fast yielding and nutritious source of food and a reliable source of income. Since it does not require access to land, mushroom cultivation is a viable and attractive activity for both rural farmers and peri-urban dwellers. Small-scale growing does not include any significant capital investment: mushroom substrate can be prepared from any clean agricultural waste

material, and mushrooms can be produced in temporary clean shelters. They can be cultivated on a part-time basis, and require little maintenance.

Indirectly, mushroom cultivation also provides opportunities for improving the sustainability of small farming systems through the recycling of organic matter, which can be used as a growing substrate, and then returned to the land as fertilizer.

Through the provision of income and improved nutrition, successful cultivation and trade in mushrooms can strengthen livelihood assets, which can not only reduce vulnerability to shocks, but enhance an individual's and a community's capacity to act upon other economic opportunities.

Purpose of booklet

This booklet highlights the many opportunities to, and benefits of, increasing food and income security through incorporating mushroom into livelihoods strategies. Case studies of successful outcomes from growing mushrooms as a livelihood demonstrate the benefits arising from mushroom production in terms of income, food security and consumption of healthy food. Sources of additional information and technical support for any follow-up are identified at the end of the booklet.

The booklet recognises the valuable contribution that wild edible fungi make to the livelihoods of rural people in both tropical and temperate zones. However, this booklet does not focus on wild harvest production, but it does recognize that the subsequent processing, packaging and marketing of mushrooms is similar for both cultivated and wild harvest types.

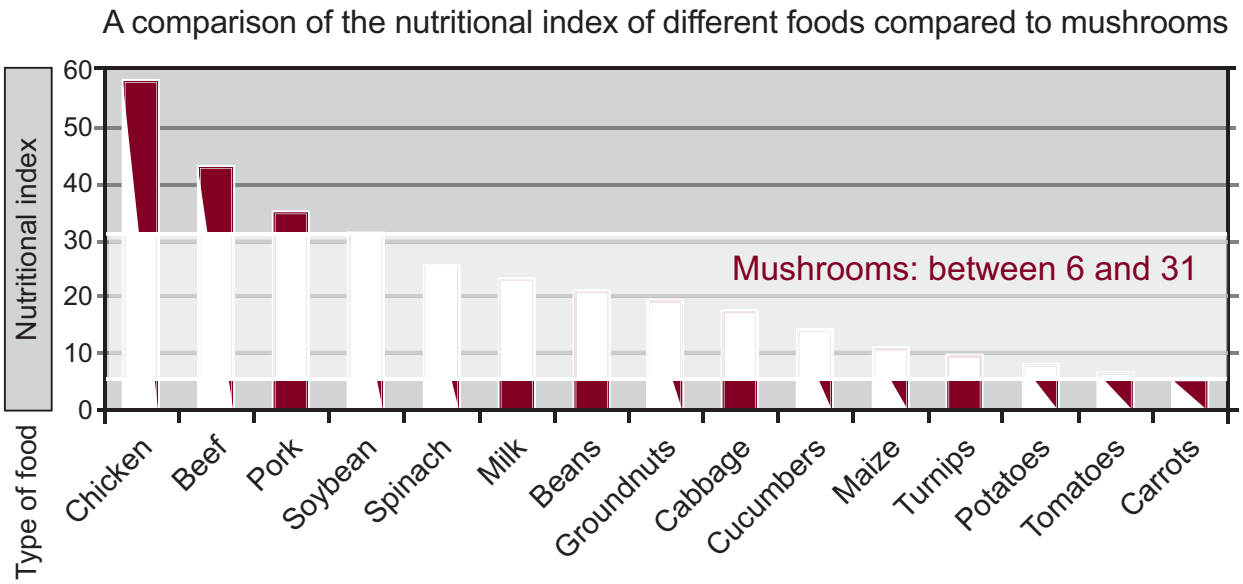
Mushrooms and sustainable livelihoods

Mushroom cultivation can directly improve livelihoods through economic, nutritional and medicinal contributions. However, it is essential to note that some mushrooms are poisonous and may even be lethal, thus the need for extra caution in identifying those species that can be consumed as food.

Nutritional value

Mushrooms both add flavour to bland staple foods and are a valuable food in their own right: they are often considered to provide a fair substitute for meat, with at least a comparable nutritional value to many vegetables. The consumption of mushrooms can make a valuable addition to the often unbalanced diets of people in developing countries. Fresh mushrooms have a high water content, around 90 percent, so drying them is an effective way to both prolonge their shelf-life and preserve their flavour and nutrients.

FIGURE 1 A comparison of the nutritional index (essential amino acids, vitamins and minerals) of different foods compared to mushrooms



Source: FAO. 2004. Wild edible fungi, a global overview of their use and importance to people, by E. Boa, Non-Wood Forest Products, No.17, Rome.

Mushrooms are a good source of vitamin B, C and D, including niacin, riboflavin, thiamine, and folate, and various minerals including potassium, phosphorus, calcium, magnesium, iron and copper. They provide carbohydrates, but are low in fat and fibre, and contain no starch. Furthermore, edible mushrooms are an excellent source of high quality protein (reportedly between 19 percent and 35 percent), and white button mushrooms contain more protein than kidney beans. In addition to all the essential amino acids, some mushrooms have medicinal benefits of certain polysaccharides, which are known to boost the immune system.

Medicinal value

Recently, there has been a spectacular growth in, and commercial activity associated with, dietary supplements, functional foods and other products that are 'more than just food'. Medicinal fungi have routinely been used in traditional Chinese medicine. Today, an estimated six percent of edible mushrooms are known to have medicinal properties and can be found in health tonics, tinctures, teas, soups and herbal formulas. *Lentinula edodes* (shiitake) and *Volvariella volvacea* (Chinese or straw mushroom) are edible fungi with medicinal properties widely diffused and cultivated.

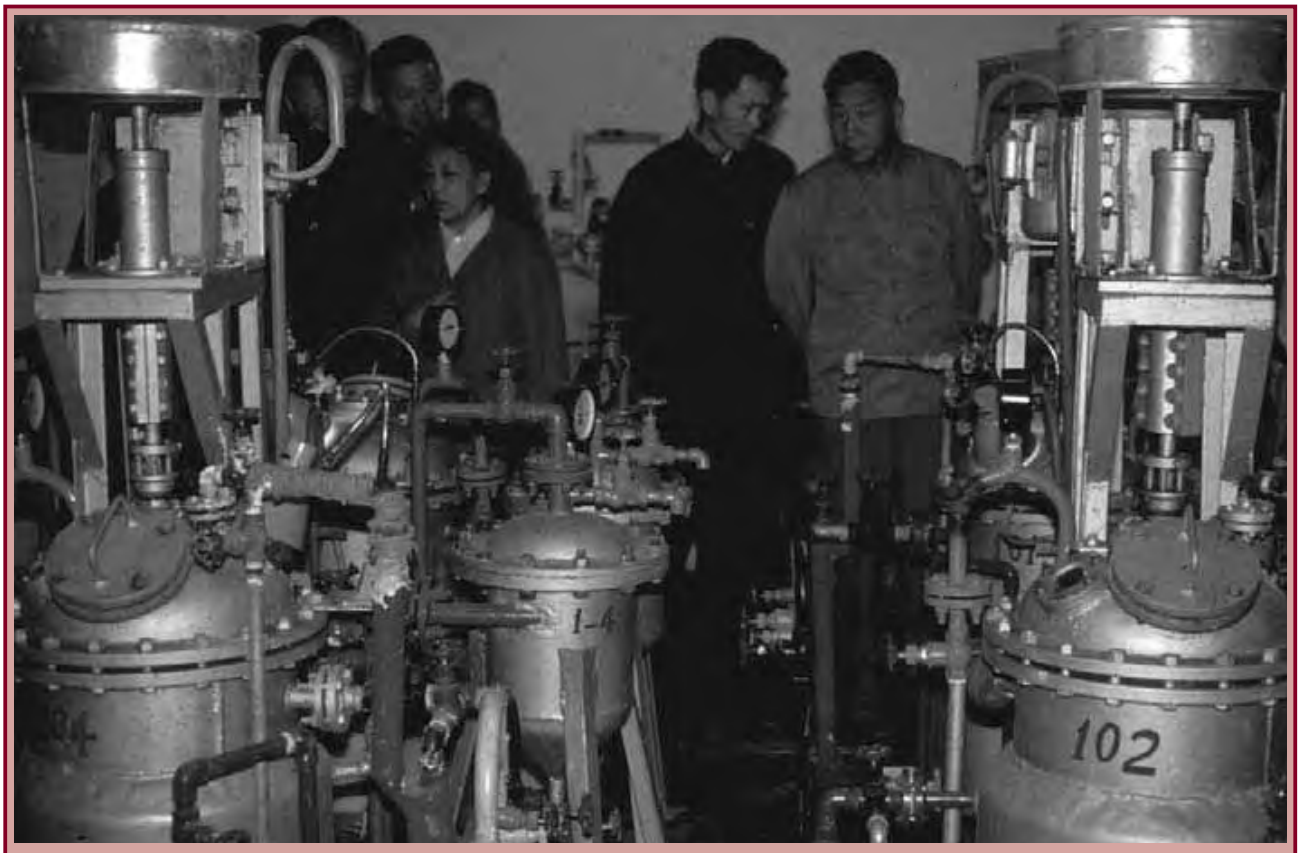


FIGURE 2 Production of bioactive compounds from mushrooms
(Photo by N. G. Nair)

The medicinal properties of mushrooms depend on several bioactive compounds and their bioactivity depends on how mushrooms are prepared and eaten. Shiitake are said to have anti-tumour and antiviral properties and remove serum cholesterol from the blood stream. Other species, such as *Pleurotus* (oyster), *Auricularia* (mu-er), *Flammulina* (enokitake), *Termella* (yin-er) and *Grifola* (maitake), all have varying degrees of immune system boosting, lipid-lowering, anti-tumour, microbial and viral properties, blood pressure regulating, and other therapeutic effects. Mushrooms represent a vast source of yet undiscovered potent pharmaceutical products and their biochemistry would merit further investigation.

Income benefits

Mushroom cultivation activities can play an important role in supporting the local economy by contributing to subsistence food security, nutrition, and medicine; generating additional employment and income through local, regional and national trade; and offering opportunities for processing enterprises (such as pickling and drying) (see Case Study 1).

CASE STUDY 1 **A community mushrooming business in Tanzania**

In many parts of Africa, edible fungi are an important food source, but in the Hai district of Northeastern Tanzania, many community members traditionally perceived mushrooms to be poisonous. Until a few years ago, oyster mushrooms were considered to be an expensive luxury food for urban consumers and not of interest to resource poor households. Despite these initial challenges, a project initiated in May 2005, led by the Horticultural Research Institute Tengeru and supported by FARM-Africa's Maendeleo Agricultural Technology Fund, has resulted in almost 300 Hai farmers adopting oyster mushroom production in their homes.

The Kilimanjaro highlands were once a thriving banana and coffee growing region, but with falling world market prices for coffee and unreliable rain in the lowlands, farmers have struggled to earn an income and produce enough food. Households have become poorer and malnutrition amongst children has increased. However, Hai farmers became gradually convinced of the value of cultivating and consuming oyster mushrooms after attending training and a series of cooking demonstrations held by Horti-Tengeru during 2005. The production cycle takes about 6 to 12 weeks, and the crop can be cultivated year-round.

The benefits of growing and selling mushrooms have enabled farmers to buy livestock (chickens and goats), pay school fees and household goods, and a number of farmers have invested in expanding their mushroom production. The benefits to the household have also included improved nutrition. (Consumption of animal protein is low in most households, even those with livestock.) Oyster mushrooms are rich in protein and provide an affordable alternative. A number of households have now adopted a recommended preparation of mushroom stew, which is eaten with rice or a stiff porridge.

CASE STUDY 1 **A community mushrooming business in Tanzania** *(continued)*

Mushroom growing involves all members of the community. Younger group members help the older people by preparing the substrates (chopping and pasteurisation) and mixing the spawn collectively. Individuals are then given the spawned bags to take home. Farmer groups also share use of equipment, such as pasteurisation drums, drying trays or solar driers.

Poverty amongst some group members is also still a constraint as many lack space for the mushroom growing structures. However, farmers are encouraged to rent rooms and a revolving fund has been set up to allow them to buy their planting material. The majority paid back at least half the loan within the first production cycle.

By mid 2006, one year after the introduction of the crop, growers were selling their mushrooms to local informal markets and also to hotels and supermarkets in Arusha and Moshi, including a major supermarket.

Demand for oyster mushrooms in Hai and neighbouring districts currently exceeds supply, indicating potential for further growth. To maintain demand, mushroom quality, good packaging and consistent production will have to be sustained. Farmer groups have demonstrated their innovativeness in finding a variety of ways to improve their products. One group, for example, has discovered a method for processing quality dry mushroom without using a solar drier, while an individual farmer processes his mushrooms by pickling.

Farmers are now training others in mushroom production. Recipes including mushroom stew, soup and samosas have been devised and are prepared during field days, and the technologies for processing the mushrooms for sale are also demonstrated. The Hai district council provides support by funding transport for extension staff to disseminate the mushroom technologies to farmers not yet involved in the project. For established farmers the next step is to produce mushrooms on a larger scale and market collectively. With support from Horti-Tengeru, the farmers groups are gradually being transformed into business units through the formation and registration of mushroom savings and credit societies, which will be responsible for the effective marketing of mushroom products for the benefit of members.

Source: New Agriculturalist. 2007. A mushroom business in Tanzania. (http://www.new-ag.info/07/03/focuson/focuson2.php)

Income from mushrooms can supplement cash flow, providing either:

- **a safety net** during critical times, preventing people falling into greater poverty;
- **a gap-filling** activity which can help spread income and generally make poverty more bearable through improved nutrition and higher income; or
- **a stepping stone** activity to help make people less poor, or even permanently lift them out of poverty.

Livelihood opportunities

Trade in cultivated mushrooms can provide a readily available and important source of cash income - for men and women and the old, infirm and disabled alike (see Case Study 2).

The role played by women in rural mushroom production can be very significant. Certain parts of the mushroom cultivation process, such as filling substrates in containers and harvesting, are ideally suited for women's participation. Several programmes have enhanced women's empowerement through mushroom production by giving them the opportunity to gain farming skills, financial independence and self-respect.

CASE STUDY 2 **Opportunities for the disabled**

One of the best examples of opportunities in mushroom growing for the disabled can be seen in the recent pioneering programme undertaken by the FAO Regional Office for Asia and the Pacific in the poor Northeastern part of Thailand. The main aim of the project was to enhance opportunities for rural people with disabilities to become self-reliant and to show their capabilities, allowing them to re-integrate their community and be active members of society.

Several positive outcomes were achieved through training people with disabilities:

- People with disabilities can do almost everything that is required for establishing a successful mushroom growing enterprise.
- The trainees gained self-satisfaction and self-esteem, and several became physically stronger.
- Trainees with mental disabilities demonstrated good skills in basic bookkeeping and developing marketing strategies.
- Many trainees became trainers.
- Trainees taught mushroom growing techniques to their family members who support them and have found mushroom growing to be an important source of household income.

Source: New Agriculturalist. 2007. A mushroom business in Tanzania. (http://www.new-ag.info/07/03/focuson/focuson2.php)

Essentials of mushroom cultivation

Fungi come in many shapes, sizes and colours. Macrofungi is a general category used for species that have a visible structure that produces spores, which are generically referred to as fruiting bodies. Unlike the leaves of green plants, which contain chlorophyll to absorb light energy for photosynthesis (the process by which plants convert carbon dioxide and water into organic chemicals), mushrooms rely on other plant material (the substrate) for their food.

Life cycle of a mushroom

The key life cycle stages for fungi (see Figure 3) are as follows:

Vegetative growth of the mycelium in the substrate

As spores, released from the gills, germinate and develop they form hyphae, which are the main mode of vegetative growth in fungi. Collectively, these are referred to as mycelium, and these feed, grow and ultimately produce mushrooms (in most species). Mycelium appears as microscopic threads similar in appearance to the mould that sometimes grows on bread.

Reproductive growth when the fruit bodies are formed

The appearance of fruiting bodies or mushroom varies according to the species, but all have a vertical stalk (stipe) and a head (pileus or cap).

Production of spores by the mushroom fruit bodies

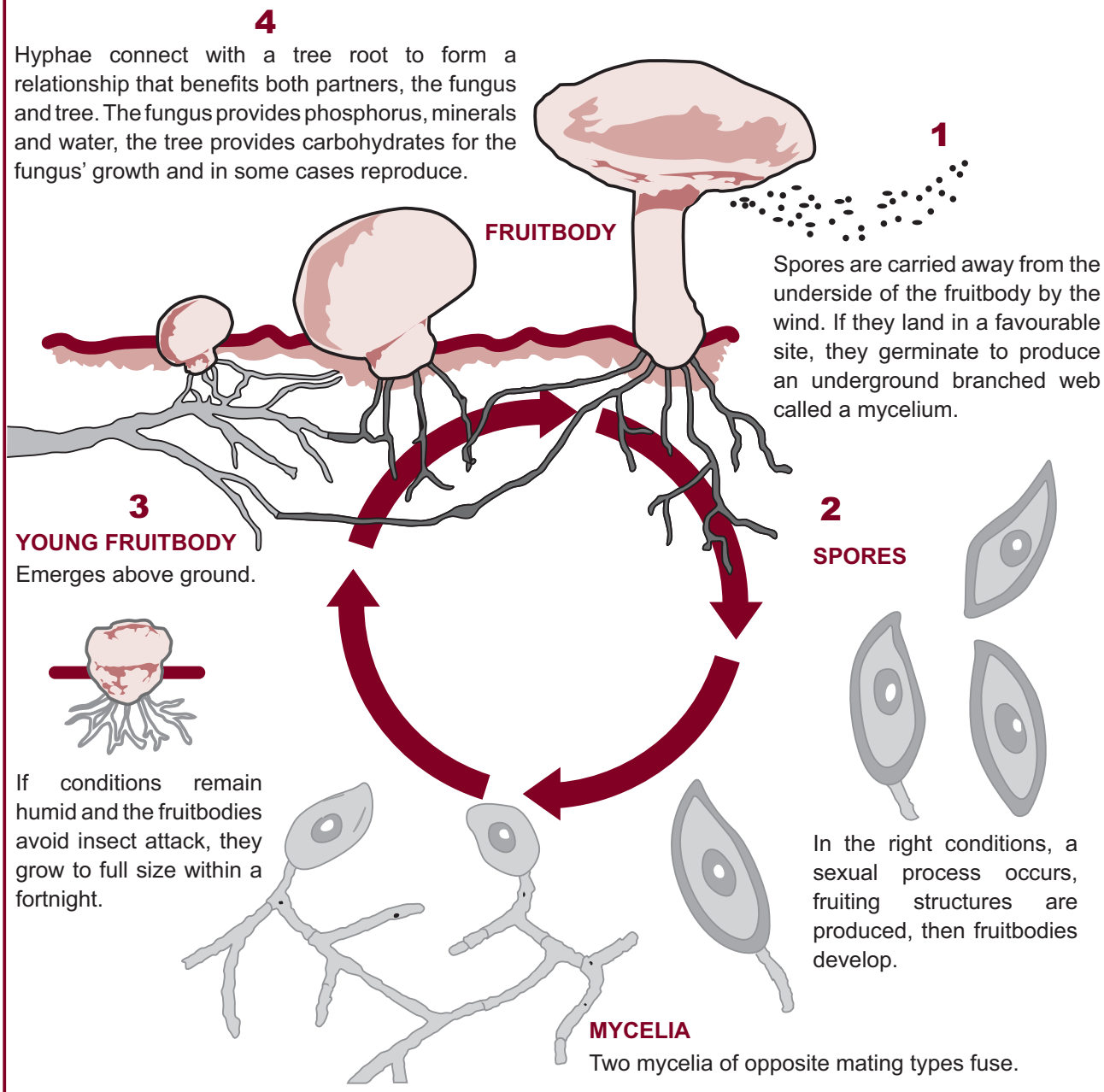
The underside of the cap has gills or pores from which mushroom spores are produced. The mushroom produces several million spores in its life, and this life cycle is repeated each time the spores germinate to form the mycelium.

Growing systems

Cultivated mushrooms are edible fungi that grow on decaying organic matter. Mushrooms obtain their nutrients in three basic ways:

1. **Saprobic**, growing on dead organic matter. Saprobic edible fungi can be wild harvested, but are most widely valued as a source of food and medicine in their cultivated forms. They need a constant supply of

FIGURE 3 Life cycle of a mushroom



Source: Adapted from geocities.com by Fabio Ricci.

suitable organic matter to sustain production and, in the wild, this can be a limiting factor in production.

2 Symbiotic, growing in association with other organisms.

The majority of wild edible fungi species (e.g. chanterelles - *Cantharellus* and *Amanita* species) are symbiotic and commonly form mycorrhizas with trees, where the fungus helps the tree gather water

from a wider catchment and delivers nutrients from the soil that the tree cannot access and the tree provides the fungus with essential carbohydrates. (Detailed and globally comprehensive recommendations on the sustainable collection and management of wild fungi are provided in FAO, 2004.)

3 **Pathogenic or parasitic**, plant pathogenic fungi cause diseases of plants and a small number of these microfungi are eaten in the form of infected host material.

Essentially, mushroom species can be cultivated in two ways:

Composted substrates: wheat and rice straw, corn cobs, hay, water hyacinth, composted manure, and various other agricultural by-products including coffee husks and banana leaves (see Case Study 3);
Woody substrates**:** logs or sawdust.

Generally, each mushroom species prefers a particular growing medium, although some species can grow on a wide range of materials (see Box 1). This booklet focuses on cultivating

CASE STUDY 3 **Utilising water hyacinth as mushroom substrate in Malawi**

Water hyacinth *(Eichornia crassipes)* is a waterweed present in many of the rivers of Malawi. It causes serious problems, such as reduced water quality and fish populations, blocked irrigation and drainage systems, hinders river navigation, and promotes the growth of vectors of insect-borne diseases and bilharzias. However, it is high in nitrogen.

Several groups of rural women are using water hyacinth as the substrate for growing oyster mushroom *(Pleurotus sajor-caju)*. They do not require much land and use simple growing methods. There is an abundant supply of the substrate because the weed regenerates rapidly. Since most of the materials needed for mushroom growing are obtained locally the cultivation process is economically viable.

There are plans to grow other types of mushrooms such as *Ganoderma lucidum* and *Agaricus bisporus*. Since the domestic production of mushrooms in Malawi (6.5 metric tonnes/year) is significantly lower than that of the annual demand (80 metric tonnes/year), the future for mushroom cultivation for trade, as a livelihood activity, looks promising.

OXFAM, the United Nations Development Programme (UNDP) and the Ministry of Commerce and Industry funded 'The Enterprise Development and Training Agency' in Malawi, which provide training to farmers on mushroom growing as an alternative livelihood strategy.

Source: Mkoka, C. 2003. Malawi turns world's worst waterweed into a lucrative business. (http://www.islamonline.net/english/science/2003/09/article03.shtml)

saprobic species. Some mushrooms - matsutakes and chanterelles - can also be cultivated by inoculation of tree roots with species that form mycorrhizae that then infect the roots, as with truffles; however this is not covered by this booklet (see Hall *et al,* 1998).

BOX 1 **Key mushroom species and their corresponding cultivation medium**

Growing Medium	Mushroom Species
Rice straw	Straw (*Volvariella)*, Oyster (*Pleurotus*), Common (*Agaricus*)
Wheat straw	Oyster (*Pleurotus*), Common (*Agaricus*), Straw (*Volvariella*), Roundhead (*Stropharia*)
Coffee pulp	Oyster (*Pleurotus*), Shiitake (*Lentinus*)
Sawdust	Shiitake (*Lentinus*), Oyster (*Pleurotus*), Lion's Head or Pom Pom (*Hericium*), Ear (*Auricularis*), Ganoderma (*Reishi*), Maitake (*Grifola frondosa*), Winter (*Flammulina*)
Sawdust-straw	Oyster (*Pleurotus*), Roundhead (*Stropharia*)
Cotton waste from textile industry	Oyster (*Pleurotus*), Straw (*Volvariella*)
Cotton seed hulls	Oyster (*Pleurotus*), Shiitake (*Lentinus*)
Logs	Nameko (*Pholiota*), Shiitake (*Lentinus*), White jelly (*Tremella*)
Sawdust-rice bran	Nameko (*Pholiota*), Ear (*Auricularis*), Shaggy Mane (*Coprinus*), Winter (*Flammulina*), Shiitake (*Lentinus*)
Corncobs	Oyster (*Pleurotus*), Lion's Head or Pom Pom (*Hericium*), Shiitake (*Lentinus*)
Paper	Oyster (*Pleurotus*), Roundhead (*Stropharia*)
Horse manure (fresh or composted)	Common (*Agaricus*)
Molasses waste from sugar industry	Oyster (*Pleurotus*)
Water hyacinth/Water lily	Oyster (*Pleurotus*), Straw (*Volvariella*)
Oil palm waste	Straw (*Volvariella*)
Bean straw	Oyster (*Pleurotus*)
Cotton straw	Oyster (*Pleurotus*)
Cocoa shell waste	Oyster (*Pleurotus*)
Coir	Oyster (*Pleurotus*)
Banana leaves	Straw (*Volvariella*)
Distillers grain waste	Lion's Head or Pom Pom (*Hericium*)

Source: Beetz, A. & Kustudia, M. 2004. Mushroom cultivation and marketing. Horticulture Production Guide. ATTRA Publication IP 087.

Key steps in mushroom production

The basic concept in cultivation is to start with some mushroom spores, which grow into mycelium and expand into a mass sufficient in volume and stored up energy to support the final phase of the mushroom reproductive cycle, which is the formation of fruiting bodies or mushrooms.

The key generic steps in mushroom production – a cycle that takes between one to three months from start to finish depending on species – are:

1

identifying and cleaning a dedicated room or building in which temperature, moisture and sanitary conditions can be controlled to grow mushrooms in;

2

choosing a growing medium and storing the raw ingredients in a clean place under cover and protected from rain;

3

pasteurising or sterilizing the medium and bags in which, or tables on which, mushrooms will be grown (to exclude other fungi that would compete for the same space - once the selected fungi has colonized the substrate it can fight off the competition);

4

seeding the beds with spawn (spores from mature mushrooms grown on sterile media);

5

maintaining optimal temperature, moisture, hygiene and other conditions for mycelium growth and fruiting, which is the most challenging step; adding water to the substrate to raise the moisture content since it helps ensure efficient sterilization;

6

harvesting and eating, or processing, packaging and selling the mushrooms;

7

cleaning the facility and beginning again.

Spawn and inoculation

Mushroom spawn is purchased from specialist mushroom spawn producers, and there are several types or strains of spawn for each type of mushroom. It is not generally advisable for mushroom growers to make their own spawn because of the care needed to maintain the quality of spawn in the production process.

FIGURE 4 Incubation of mushroom spawn under hygienic conditions
(Photo by N. G. Nair)

FIGURE 5 Bag system for Agaricus bisporus
(Photo by N. G. Nair)

Spawn is produced by inoculating a pasteurised medium, usually grain, with the sterile culture (grown from spores) of a particular mushroom species.

The cheapest cultivation system using composted substrate is one where mushrooms are grown in plastic bags (which can be sterilized and re-used with new substrate) containing substrate or compost, in a simple building to provide controlled growing conditions. Bottles can also be used, and in other indoor low cost systems wooden trays of different sizes can be arranged in stacks to provide a useful cultivating space. Spawn is added to the sterilized/ pasteurised substrate under hygienic conditions, in an enclosed space, and mixed thoroughly to ensure that the mushroom mycelium grows evenly throughout the substrate.

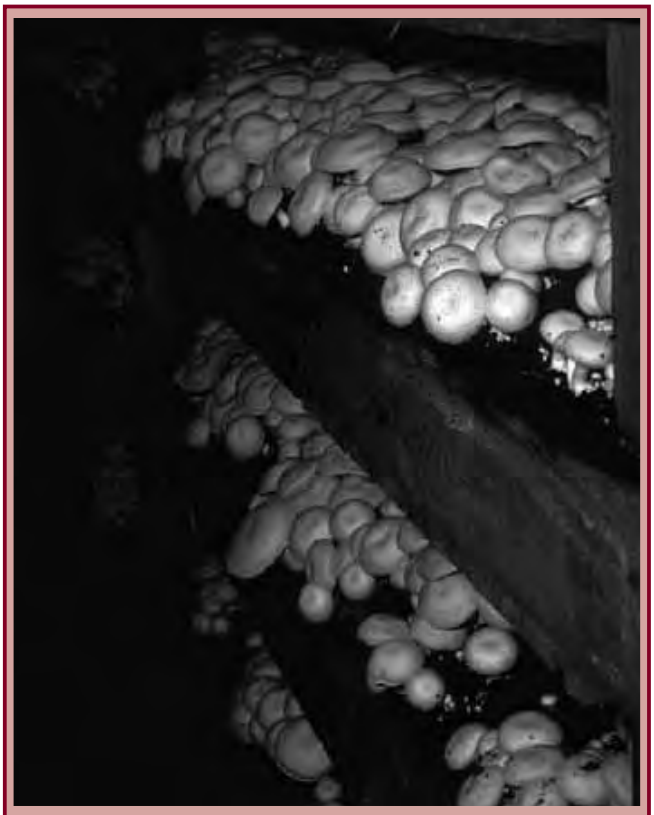


FIGURE 6 Tray system for Agaricus bisporus (Photo by N. G. Nair)

Farmers with limited resources can overcome the need to purchase spawn each time a new crop is put down by removing a portion of the substrate colonized by the mushroom spawn from the new crop and using it for spawning the following crop. However, care must be taken to remove only healthy, uninfected substrate colonized fully by the mushroom spawn.

Maintaining suitable growing conditions

The inoculated substrate is put into bags, trays, etc. and transferred to an enclosed and darkened room or building to incubate for a period of up to 12 weeks, depending on the variety of mushroom. If space is limited, plastic bags can be suspended in darkened rooms.

Humidity levels are important for the mycelium to colonise over the next two weeks, so water needs to be available, and the temperature controlled accordingly to the variety of mushroom. The crop should be protected from sunlight and strong winds at all times, which can cause the mushrooms to dry out. Humidity can be maintained in the growing room

by hanging wet rags at several points around the walls, or watering the floor. Temperature can be regulated by a fire, (electric if available) and cooling could be assisted by using a table fan blowing over a container of water, and air circulating between the sacks should help assist with temperature regulation.

It is essential to maintain hygienic conditions over the general cropping area, in order to protect the crop from contamination.

Harvesting cultivated mushrooms

The transition from fully-grown mycelium to produce mushroom fruiting bodies normally requires a change in the environmental conditions, such as temperature decrease and ventilation and humidity increase. Mushrooms fruit in breaks or flushes, and the type and size of mushrooms harvested depend on the type of mushrooms grown and market demand.

Mushrooms should be harvested according to market demand; for example, there may be a price premium for small button mushrooms. Generally mushrooms are harvested by hand using sterilized knives to cut the ones that are ready. Pickers should be trained to recognise the appropriate stage for harvesting and be consistent in when the mushrooms are cropped. Handling such a perishable crop should be kept to a minimum to reduce the risk of damage.

Marketing mushrooms

Harvested mushrooms need to be carefully handled and should be kept in a container that allows for air circulation, such as a basket, and care needs to be taken to prevent bruising. The baskets containing mushrooms should be covered to keep flies out and protected from sunlight, high temperatures and draughts. High quality mushrooms that are healthy and clean fetch the best market price. Harvested mushrooms should be taken to market without delay in order to maintain their freshness and quality, or stored in a refrigerated environment or processed.

Getting fresh specimens to market is considerably difficult, both for wild fungi and cultivated mushrooms. The physical appearance of fruiting bodies is obviously important and customer preferences must be observed. Some species discolour if the gills or cap are damaged and they must be handled with care. Depending on the soil where the fungi grow, some preliminary cleaning of gills and gaps may be needed to remove particles. Picking fruiting bodies at the correct stage of development is important. As they mature, some species become woody

and much less desirable, while others rot away.

Pest and disease management

The basic principle in protecting the mushroom crop from pests and diseases is prevention, largely achieved through good hygiene. As mushrooms are grown mostly in an enclosed environment, the risk of pests and diseases spreading rapidly within the crop is high, so it is important to monitor the crop on a daily basis for incidence of pests and diseases, to prevent losing at least some of the crop. It is also important to sterilize the growing room and the preparation areas on a regular basis.

If and when pests or diseases are detected, control measures should be applied immediately. This may involve removing infected mushrooms by carefully picking them off without spreading the disease, then applying a pesticide. The type of pesticide required should be carefully chosen from a list of registered chemicals and used strictly in accordance with the directions given on the label. Further information on Integrated Pest Management is available from the National Sustainable Agriculture Information Service (ATTRA) and FAO.

Scale of production

Growing systems should be selected that are best suited to local conditions and based on the assets available (see Box 2). Many species of mushrooms can be successfully cultivated on a small-scale, by farmers and other growers who have limited access to resources and vulnerable to risk. It is quite possible for growers to gradually shift from a low-cost system to a higher cost production process, with greater output, when they have gained sufficient skills and income.

Large-scale commercial methods of mushroom cultivation require significant financial investment to purchase steam sterilizers, and technical equipment for sterilization such as auto claves, and often have

BOX 2 Flexibility in selecting a growing system is important

In Zimbabwe, the Chakohwa Voluntary Mothers Group mushroom growing venture started with white button mushrooms. However, button mushrooms need horse manure in the substrate, but this was not available in their area so the project switched to oyster mushrooms that can grow on locally available materials.

Source: Noble, N. 2005. Mushroom growing-a practical guide, Technical Brief, Practical Action.

laboratory facilities to produce spores.

Species selection

Although there has been a great amount of research into mushrooms and their cultivation in temperate climates, there has unfortunately been comparatively little on varieties suitable for tropical climates. Many commercial mushrooms only fruit at around 20 °C and are therefore not suitable for tropical regions. Suitable tropical strains are harder to obtain, but some commercial strains can be ordered which fruit at higher temperatures and local laboratories which manufacture spore will be best placed to advise on appropriate varieties and in providing advice on best planting practices.

The key factors to consider when selecting a species to cultivate are summarized in Box 3.

BOX 3 Factors influencing the selection of mushroom species

Availability of waste materials to use as a growth medium. Not all mushrooms can be grown in the same substrate.

Environmental conditions. Different species have different requirements for temperature and other environmental variables.

Available expertise. Some mushrooms are more difficult to grow than others and, if there is little available expertise locally, farmers should start with easy species like oyster (*Pleurotus species*) which grow on many substrates and are easy for beginners; shiitake (*Lentinus edodes*) and maitake (*Grifola frondosa*) are other possibilities.

Available resources. It is necessary to dentify what necessary equipment (see physical assets) is needed and/or already available.

Market demand. If producers wish to trade.

Source: Adapted from Beetz, A. & Kustudia, M .2004.Mushroom cultivation and marketing, Horticultural Production Guide, ATTRA Publication IP 087.

Key species and their cultivation methods

Detailed in the following pages are a few species of commonly cultivated edible mushrooms that are of global relevance.

1 *Agaricus bisporus*

The white button mushroom is the most cultivated mushroom in the world, of particular importance in temperate regions. It is grown in composted substrate and is commonly

cultivated in higher technology systems, requiring a low temperature of between 14 to 18 °C to provide optimal fruiting conditions for the mushroom and for best results in cultivation. (See Box 4).

BOX 4 Cultivating mushrooms in hot climates – examples from Namibia

The most commonly cultivated mushroom is the button mushroom, but as a temperate species it does not do well in hot climates. In addition, all fungi like moist environments, so humidity needs to be controlled in drier climates. Button mushrooms could be cultivated in coastal regions of hot countries and, in Namibia, some have been cultivated in old mine shafts (avoiding water contaminated by heavy metals or other toxins), where temperatures are low and humidity is high.

Countries with hot climates lend themselves better to the production of tropical mushrooms, such as oyster mushroom, which is the second most cultivated mushroom in the world. Oyster and shiitake mushrooms are better suited to high temperatures, and grow well in Namibia where humidity can be maintained.

Source: Fuller, B. & Prommer, I .2000. (Eds.) Population-development-environment in Namibia, Background readings, Interim Report, International Institute for Applied Systems Analysis.

FIGURE 7 Agaricus bisporus
(Photo by N. G. Nair)

FIGURE 8 Pleurotus ostreatus
(Photo by N. G. Nair)

2 *Pleurotus ostreatus*

Oyster mushrooms are a good choice for inexperienced cultivators because they are easier to grow than many other species. In addition, they can become an integral part of a sustainable agriculture system utilising organic waste, can be grown on a small-scale with a moderate initial investment, and convert high amounts of substrate to fruiting bodies thereby increasing potential profitability.

Oyster mushrooms were first cultivated on tree logs, and are now commonly grown on sawdust, wheat or rice straw and a variety of high-cellulose waste materials, which has shortened the fruiting period to about two months. Cultivation merely involves placing the sterilized and inoculated substrate in plastic bags, and keeping them in the cool and dark. Once the mycelium has grown throughout the substrate, openings are cut through the bag to allow fruiting bodies to develop.

Nevertheless, they have some drawbacks. These mushrooms have a soft and fragile structure; the shortest shelf-life of any cultivated mushroom, often displaying bacterial

FIGURE 9 Lentinus edodes
(Photo by N. G. Nair)

or fungal contamination within a day or two of arriving at the market place. Some people are allergic to the spores, which are produced in profusion when the fruiting bodies start to emerge from growing bags, requiring at minimum a face mask to work in production areas (and air-cleaning equipment or respirators in more high technological systems).

3 *Lentinus edodes*

Shiitake mushrooms are well suited as a low-input alternative enterprise because they can also be grown on a small-scale with a moderate initial investment. Shiitake are grown outside on logs, or inside and outside on compressed sawdust or in bottles or bags. A cultivation system using compressed sawdust and bags allows for a much faster fruiting cycle and a high level of return, but requires more skilful management than log production. The smaller the diameter of substrate logs, the quicker fruiting bodies appear, although production lasts for a shorter time, and the denser the wood, the longer the production will last. In the same way as substrate, logs are inoculated with spawn from a suitable and locally sourced strain

and, as the spawn develops and the mycelium grow throughout the log, it must be kept shaded, moist, and out of the wind. When the mycelium has fully occupied the logs and the temperature and humidity are right for fruiting, the mycelium will initiate tiny 'pinheads' on the surface of the log, which will grow into mushrooms within a few days (see Case Study 4).

CASE STUDY 4 Livelihood opportunities in the Republic of Korea

The production of shiitake mushrooms (*Lentinus edodes*) provides growers in the rural economy, in the Republic of Korea, with an important source of income. The growers live in areas where oak logs can be obtained. The majority of the growers do not own forests and grow the mushroom crop in agricultural fields under artificial shade. They buy oak logs from timber merchants or use sawdust imported from China.

Mushroom growing relies on labour from within the family. Women play an important role in mushroom cultivation, inoculating the logs or sawdust, harvesting mushrooms and drying the harvested mushrooms.

The growers are members of a cooperative, the Mushroom Growers Club. The marketing strategy demonstrates the strength coming from cooperation, using different methods for fresh and dried mushrooms. Mushrooms for fresh use are grown near urban consumers, and farmers situated far from consumers market their product after drying. The cooperative also provides farmers with a loan service, while the government provides technical support.

Source: Youn,Y. C. 2004. The production of oak mushrooms (Lentinula elodes) as a source of farmers' income in the Republic of Korea: the case of Cheongyang-Gun, In K. Custers & B. Belcher,eds. Forest products, livelihoods and conservation: case studies of non-timber forest products systems, Vol.1 Asia, Centre for International Forestry Research, Indonesia.
(http://www.cifor.cgiar.org/publications/pdf_files/Books/NTFPAsia/Chapter6-Chapter11.pdf)

FIGURE 10 Volvariella volvacea
(Photo by N. G. Nair)

4 *Volvariella volvacea*

Paddy straw mushroom cultivation is often integrated with rice production across much of Southeast Asia, including Viet Nam. The mushrooms also grow on substrates in addition to paddy straw, including rice straw, cotton waste, dried banana leaves and oil palm bunch waste, but yields are lower than with paddy straw, where cultivation methods are similar to that of common or oyster mushrooms. Throughout many rural areas, including Indonesia and Malaysia, mushroom growers just leave thoroughly moistened paddy straw under trees and wait for mushrooms to appear.

Assets required for mushroom cultivation

Mushroom cultivation can play an important role in helping rural and peri-urban people strengthen their livelihoods and become less vulnerable to hunger and poverty. Their cultivation requires a wide range of activities suitable for people with various needs, diverse interests and specific capabilities. Key assets or resources associated with mushroom cultivation are described below.

Natural assets

Land and climate play a minimal role in mushroom cultivation and this feature makes the enterprise particularly suitable for farmers with limited land, as well as the landless. Unlike wild harvested fungi, grown mushrooms are not subject to any ecological uncertainties including habitat health, nor years of unpredictable production as a result of late or reduced rains.

Access to sufficient, suitable and locally-sourced substrate and spores are key determinants as to whether mushroom cultivation is likely to be successful and sustainable or not. Both rural farmers and peri-urban cultivators should be able to obtain agricultural by-products easily and cheaply to use as substrate; or, for certain mushroom species, logs or sawdust to inoculate with spores. Mushroom spores can be collected from mature fruiting bodies, but are commonly purchased from local production facilities or laboratories.

Mushroom cultivation is compatible with other farming and horticultural activities (see Box 5). It can be regarded as a very efficient system in recycling with no waste from production to consumption.

BOX 5 **Rice farming and mushroom growing**

In several countries of the Asia-Pacific region mushroom cultivation is integrated into rice farming. In China and Viet Nam millions of rice farmers integrate rice farming and rice straw mushroom cultivation. After rice harvest the straw waste is used as the substrate for growing *Volvariella volvacea*. Rice straw can also form a component of the substrate used for growing other species of mushrooms.

CASE STUDY 5 **Marketing strategy, Biovillage Programme, India**

The Biovillage Programme, connected with mushroom growing in India, was initiated by the M.S.Swaminathan Research Foundation. Its mission is to improve the livelihoods of villagers in several localities in India. It offers new enterprises to bring new incomes, encourages the need for cooperation among enterprises and training workshops to expand the knowledge of the villagers in farming systems. Under this programme, a mushroom training and demonstration centre is run by the local youth and this centre produces mushroom spawn for the benefit of the farmers. The villagers have benefited not only in terms of increased incomes, but also through healthier diets as a result of consuming mushrooms.

The programme helps farmers in marketing their produce. Embedded in this marketing strategy is the crucial concept that livelihood is not about money, but about empowerment. The rural women in this programme have been given authority to create cooperative societies. Through such empowerment, the women have been able to achieve things that as individuals they would not have been able to. The programme has assisted villagers in establishing market linkages with local markets or market in larger cities. This is a significant part of mushroom growing for livelihood, because an enterprise cannot increase villagers' livelihoods unless they are able to transform their produce into financial returns. The formation of cooperative societies brought about significant advances in the villagers' personal worth and skills to manage small enterprises.

Some of the advantages resulting from a cooperative approach

Villagers become confident as individuals in making decisions on all aspects of farming.
They are able to get credits and loans where an individual would have been denied.
There is a willingness to exchange knowledge, skills and resources at the practical level.
When labour shortages occur, the villagers are willing to share the workload.
The marketing costs are shared.
The farmers are willing to look beyond competitiveness in marketing to the common good.
They are able to make well informed decisions on the basis of shared knowledge.
As the number of cooperatives grow, more individuals become involved.

Under this programme mushroom growing has continued to be a popular enterprise as the number of villagers has seen the possible increases in income that mushroom production can bring. These successes enabled the programme to spread from one village to another.

Source: ACDI & SIDA

A sterilized composted substrate once inoculated with spawn, can be used for three harvests and then recycled by incorporating it as an organic mulch or fertilizer in other horticultural or agricultural systems, which can improve soil structure, or it can be used as a nutritious fodder for poultry.

Social assets

People draw upon formal and informal resources to help meet their livelihood objectives, including networks and support from families, friends, organizations and membership of groups, such as mushroom growers associations. These contacts collectively strengthen the individual by helping them and their communities access information and resources including technical information, basic training, sources of mushroom spores, and marketing outlets to sell their crop.

Cultural, social and organizational issues are important for determining the direct and indirect benefits of mushroom trade for different social groups. As a result of the high perishability of mushrooms, it can be of great benefit, for small-scale cultivators selling their crop, to be organized with other growers and to share transport costs, market contacts, etc. In addition, working in collaboration with other growers may enable cultivators to establish local production, processing, or packaging facilities to increase harvest output or product shelf-life i.e. a drying facility (See Case Study 5).

Mushroom cultivation represents a very suitable and empowering income generating option for women in particular, because it can be combined with traditional domestic duties and can be undertaken at home. Several programmes related to rural mushroom production have given women the opportunity to gain financial independence, farming skills and higher self-esteem.

Human assets

Human assets relate to the skills, knowledge, ability to work and level of health that people need to pursue different livelihood strategies and to achieve their objectives. Mushrooms are not labour intensive and can be undertaken as an additional livelihood activity which fits around other household or productive tasks. People with physical disabilities are fully capable of accomplishing all necessary tasks in mushroom cultivation, even if some modifications in construction, equipment and tasks are required. People with mental disabilities can also grow mushrooms because several of the key tasks are repetitive

and can be easily learned. Mushroom cultivation can also be a feasible livelihood activity for chronically ill or weak people, who may benefit from working in a cooler, shaded environment with minimal physical exertion, in contrast to the more arduous work input often associated with other horticultural products.

Many societies have considerable traditional knowledge and skills relating to farming activities and the management of natural resources, but the cultivation of mushrooms is a relatively new activity throughout much of the rural developing world. Qualities identified as being useful for mushroom cultivators include the ability to carry out operations on time, be attentive to detail, be vigilant about pest invasions, and for marketing, excellent skills in public relations.

Physical assets

Mushroom production for local consumption and trade needs a different level of equipment and infrastructure than a small commercial enterprise. Many of the physical assets required to undertake mushroom cultivation are not exclusive items, but rather assets which help meet livelihood needs in general, including the transport and communication infrastructure, clean water, a source of energy, and buildings for shelter and storage. The more developed the infrastructure, the easier it is to establish and undertake mushroom cultivation.

Mushrooms are best cultivated indoors in a dark, cool and sterilized and enclosed building. This enables the growing conditions to be maintained most suitable for mushrooms, in terms of temperature, humidity, uniform ventilation and substrate moisture levels. Unwanted contaminants, moulds and sunlight can also be kept away from the crop. Any small room with ventilation and a cement floor can be used, and it should be possible to close off the room to the outside by shutting ventilation and doors. The interior should be arranged so that it is easy to clean at the end of each cropping cycle. The mushroom house should be well insulated (by using, for example, fibre glass wool or expanded polystyrene) to maintain a steady temperature, and concrete or clay tiles are preferable over corrugated metal for roofing. Small rooms can be made from wooden poles with stretched sacking covering the frame, and covering the sacking with a wet cement and sand mixture to produce a hard protective skin.

As growing mushrooms can attract flies, there are advantages of locating the cultivation area some

FIGURE 11 Mushroom houses with walls built from oil palm leaves
(Photo by N. G. Nair)

distance away from living spaces, either at the other end of the house or in a different building several metres away. Nets placed over doors and ventilation gaps allow air in but keep the flies out. Ideally, double entry doors reduce contamination and escaping spores.

Rural small-scale mushroom growing enterprises do not need expensive equipment and some equipment may be shared between growers.

Additional equipment and tools used can include:

- a large metal drum or pot for sterilizing the substrate in;
- bags for growing;
- brushes or soft cloths for cleaning mushrooms;
- tables to place growing bags on;
- nets to screen rooms and buildings in order to keep flies off the mushrooms;
- cartons for harvested mushrooms.

It is likely that spores are purchased from a nearby town or city, so appropriate access and transport facilities are important. Transport infrastructure is also of importance when selling mushrooms because of their perishable qualities. Consequently, in areas where the infrastructure is weak it may be beneficial for producers to process the product (by pickling, drying, etc.) to overcome these constraints.

Financial assets

Mushroom cultivation is attractive for the resource-poor for two reasons. Firstly, because mushroom cultivation can be done on any scale, the initial financial outlay to establish a basic cultivation system need not be very great, and substrate materials are often free. An example from Thailand illustrates the point: a mushroom house large enough to hold 1 000 mushroom bags can be built for less than US$15, utilising the materials available locally. Secondly, compared to many agricultural and horticultural crops, mushroom production systems have a short turn around; a harvestable crop can be produced and sold within two to four months, which is very helpful for small-scale producers.

Summary

Mushroom cultivation can make a valuable contribution to sustainable livelihoods for both rural and urban poor, because they are highly compatible with other livelihood activities, requiring minimal physical and financial inputs and resources, to be undertaken successfully. Furthermore, it represents an ideal activity for older people, those in poor health, and also people with physical and mental disabilities. Mushrooms can be cultivated on both a small and large scale to allow for personal consumption, provision of a supplemental or principal income source, or the start of a commercial enterprise. Indeed, the basic requirements centre on an identified source for purchasing spores, access to suitable substrate and the means to sterilize it, some bags and a clean, dark room to cultivate in. For people interested in experimenting, the range in types of mushrooms and cultivation techniques can prove challenging and gratifying.

Strategies for successful and sustainable mushroom trade

Mushroom cultivation is a reliable and effective way for resource poor cultivators to grow nutritious food in a short space of time. It also provides an opportunity to generate a highly tradable commodity, thereby contributing to income generation. This section gives some suggestions as to how small-scale producers might successfully identify buyers and then supply them with consistent and quality produce.

Marketing channels

There are typically three principal marketing routes for mushroom growers:

- The grower can sell directly to the consumers either at the farm gate or at local markets; however, the ability to reach distant markets is limited.
- The grower can sell to an agent who then sells the mushrooms either to local or distant markets, including exports.
- The grower can belong to a cooperative or another farm organization, which offers easy market linkages to both local and distant markets, including export markets.

In some countries certain varieties of mushrooms are sold through traders specializing in such varieties. In Japan, for example, specialist traders buy shiitake mushroom (*Lentinus edodes*) at special bidding markets and then distribute the products to retailers for domestic consumption or to trading firms for export. In the Netherlands, the white button mushroom *Agaricus bisporus* is sold through auction at the market place. The successful bidders are wholesale agents or retailers. In India, government bodies purchase mushrooms from growers.

Marketing strategies

A successful marketing programme means that growers increase their income status, which in turn creates confidence in their ability to grow mushrooms profitably.

Steps to successful marketing include:

- Being aware of market demand by talking to buyers about

volume and prices.

- Exploring various marketing options for fresh mushrooms – depending on transport infrastructure - selling directly to local customers, local traders, markets, intermediaries, regional wholesalers, local restaurants, shops or farmer cooperatives.
- Adding value and increasing the shelf-life of the mushrooms by creating processed products, including dried or pickled mushrooms, sauces, teas, extracts, etc.
- Becoming organized and teaming-up with other producers, to bulk up on volume and the variety of mushrooms, and attract traders regularly to enable reliable sales of the perishable produce.
- Sharing knowledge and experiences with other producers and, if a problem or constraint is consistent and widespread, collectively source external advice.
- Reducing initial capital investment by recycling pieces of equipment and sourcing locally, and sharing costs through informal or formal groupings.
- Identifying existing markets and trading routes, and identifying any niches to be filled (for example, organic mushrooms, fair trade or cooperative produce).

Successful marketing strategies differ according to region, transport infrastructure, market accessibility and consumer preferences. They are different for fresh and dried mushrooms, and are influenced by the species (see Case Study 6). For example, locally-grown oyster mushrooms have an advantage over imported ones because of their very limited shelf-life and their fragility, making it difficult to ship them easily. Similarly, mushrooms for fresh use tend to be grown near urban consumers, while farmers situated some distance away from their consumer base, market their product after processing.

Establishing a good relationship with a buyer by delivering a reliable quality and quantity of product is fundamental. It is important to start modestly and secure a buyer or small network of buyers to whom one can deliver a reliable supply.

The method of storage and presentation of mushrooms at the point of sale should be carefully managed and labelling produce – 'fresh' and 'grown under controlled conditions' – is a helpful marketing strategy. Unreliable claims printed on the cartons relating to the medicinal value of the mushrooms on sale should be avoided; such claims should be restricted to those species of mushrooms where substantial

CASE STUDY 6 **Product quality and market access**

The distance from production to market is a crucial factor in trading mushrooms. There are many roadside markets in Malawi which are close to the forest areas where wild fungi are harvested and also cultivated.

The roadside sellers are aware that customers will pay more for species that are fresh and presented in an attractive manner. They clean fruiting bodies and select the best to be placed at the top of piles on their stalls; some collectors try to hide mushrooms infested with insects at the bottom of trays, but such tricks rarely go undetected for long.

The most important thing is to get the fungi as quickly as possible from the forest to the stall. However, because of the perishable nature of mushrooms, sellers are forced either to sell their unsold fresh produce at the end of the day for a low price, or dry it before it perishes. As such, preserving mushrooms in brine is an important feature of trade and allows for larger quantities to be offered for sale.

Source: FAO. 2004. Wild edible fungi, a global over view of their use and importance to people, by E. Boa, Non-Wood Forest Products, No.17, Rome.

clinical data are available on their bioactive compounds.

Processing

Mushrooms are usually enjoyed fresh, but this can be problematic as most species should be consumed within three to four days of harvesting in order to avoid spoilage. Where infrastructure permits, harvesting and immediately selling to an end consumer, local market or regional wholesaler on the same day ensures a better price. In larger enterprises, cold rooms can be used to store the mushrooms before they are sent to market. Optimum storage temperature varies between 5 and 8 °C.

Processing can assist marketing, by extending shelf-life for small-scale producers until they need to sell their product, and in some cases adding value. Some infrastructural investment may be needed to undertake processing effectively and, once processed, mushrooms need to be packaged and stored carefully.

Mushrooms may be frozen and placed in airtight containers; however, unprocessed mushrooms take up a lot of room and this can be a costly way of preserving them. Mushrooms are also suitable for drying, enabling them to be stored for long periods without deteriorating; this can be done using solar drying. They can also be pickled in brine.

Organization

Good organization helps mushroom cultivators in several ways:

- improving product quality (including grading), quantity (including consistent quantities), and diversification;
- providing more cost-effective transportation and overcoming large distances to the point of sale;
- accessing market information and acting upon market intelligence, thereby increasing the ability to negotiate with other actors in the market chain;
- promoting the product, e.g. attendance at fairs;
- enabling cultivators to collectively offer sufficient produce to interest new buyers or to negotiate an improved relationship with existing buyers.

The ability of individuals or a community to organize itself for trade is influenced by a number of factors including social cohesion (affected by the ethnic and religious composition of the community), the existence of other community organizations, and the presence of charismatic individuals able to motivate people to action. Initial sources of external support can help establish or strengthen organization within communities, and social networks and organizations can help manage risks (see Case Study 7).

Accessing market information

Market information can be varied, relating to the quantity, quality and price characteristics of particular products in different markets, and is essential for entering new markets and keeping market share. Information alone, however, is not sufficient, and mushroom cultivators also need to have the capacity to respond to the information. Information scarcity is often less of a problem if mushrooms are in high demand, and information can be less of a barrier for mushrooms sold at a local or regional level. Where cultivators are located in remote areas, intermediaries are often the only source of information between producers and markets.

Education, business skills and a willingness to take risks

Education is accepted as an important factor in determining people's capacity to engage in income-generating activities, and it can have a significant impact on successful mushroom cultivation. For trading beyond a very local level, basic bookkeeping and numeracy skills are often required. Personal characteristics, such as self-confidence, a willingness and ability

CASE STUDY 7 **The magic touch of a local entrepreneur – farmer organization and empowerment through mushroom cultivation, Assam, India.**

Organizing farmers has proved a tough challenge in Northeast India's political economy, but Pranjal Baruah and the NGO Ashoka work through the medium of mushroom cultivation to organize farmers. Mushroom cultivation systems have been developed to strengthen farmer control over harvesting and sale, and the establishment of a mushroom farmers' network has enabled price and quality to be standardized. Pranjal established a mushroom lab to provide a continuous supply of quality spawns at low cost, and the farmer network offers training and a buy-back guarantee as an incentive for farmers, the landless poor, and the unemployed to get involved.

Farmers in the northeast are relatively new to the market economy. The potential of mushroom cultivation to lift economic conditions in the northeast has long been recognized because of its easy technology, low investment needed, and quick returns from cultivation; moreover, the crop is not yet tied to territorial middlemen. However, there had been little effort to enable the industry to flourish: spores were not readily available and cost too much to be viable; technical and information resources were sparse; research and development was lacking; and marketing was negligible.

Starting in Assam, Pranjal first identified the oyster mushroom as the most suitable variety and established a spawn laboratory. In order to stimulate consumer demand, he began a 'mushroom awareness drive', promoting mushroom eating at fairs, providing free samples, developing innovative recipes, making pickles, face packs, powders, and more.

There were few farmers growing mushrooms six years ago, but following recruitment and training, he has reached over 5 000 growers, and resulted in some 300 medium-sized mushroom farms across Assam that regularly produce an average of 500 kg of mushrooms in a season. This figure does not include the smaller-scale farmers, home growers, and others who have been trained, but buy their spawns elsewhere.

Current intentions are to develop advanced training for trainers and larger growers, and have these entrepreneurs 'bridge the gap' between the lab and the small growers. In addition to individual entrepreneurs, Pranjal is working with 'mushroom groups', ranging from women who grow mushrooms collectively in villages to more unconventional groups like prisoners in jails.

Pranjal has spent the last eight years learning about the mushroom trade and setting up systems to address its various facets and challenges. Known as the 'Mushroom Man of Assam', his determination and business acumen has seen his venture grow tenfold in just eight years. Pranjal knows that sticking to mushrooms and making sure his farmers are in control may be the best chance for farmers to organize in the northeast.

Source: Ashoka website. 2008.
http://www.ashoka.org/node/2584

to experiment and take risks, and in particular, attention to detail, are all useful qualities amongst mushroom cultivators.

Diversification options

In the case of mushroom cultivation, growers could diversify from growing edible mushrooms to producing mushrooms with medicinal values. This is a logical step to take since the basic skills required in growing medicinal mushrooms are the same as those for growing edible mushrooms, although the specific cultivation requirements may differ. Another diversification option would be to use the spent mushroom substrate as organic mulch in growing other horticultural crops, e.g. vegetables. This would result in not only diversification for securing additional income but also in recycling the organic waste created from mushroom cultivation. The recycling process is also an environmentally friendly way of farming.

Sustainable mushroom trade

A great benefit of mushroom cultivation is that it is a combinable and complementary activity, which is only part-time and will form one component of a livelihood strategy. As such, it helps reduce risk, and creates opportunities for increased food security and a level of income generation, as determined by the producer.

The following list summarizes some main factors which contribute to the sustainability of mushroom trade, and strengthens its contribution to livelihood security:

A good understanding of the mushroom cultivation, whether based on local knowledge or acquired through external support, allows cultivators to provide consistent and predictable quantities and qualities of mushrooms, thereby attracting buyers more easily.

Effective communication and good relationships between suppliers, growers and buyers are important to ensure effective information flows about sources or spores, substrate, other equipment, yields, crop quality etc.

Identification of a reliable level of market demand. Most agricultural, horticultural, and non-wood forest product market chains are demand driven, and establishing new chains can be a challenge. The general level of market development in areas where mushrooms are promoted is an important factor determining their market potential.

Ability to innovate, by introducing

new techniques and/or varieties is important to the sustainability of trade. External actors, whether NGOs or entrepreneurs, are particularly important in supporting innovations which can be vital to maintain trade.

Length of marketing chain can influence resilience, which may be greatest for shorter chains.

High levels of transparency, both in setting prices and in defining the rules of trade, is often linked to the concentration of market power and good producer organizations may help overcome this. The price received by growers should reflect production costs, including their labour, but these are often difficult to define because local wage rates can vary by season.

Organization can help producers and processors to be more resilient to external shocks, and markets may also be made accessible by community organization. A cooperative may be formed for marketing mushrooms produced by small villagers as well as relatively large growers. Through collective pooling of their resources and crop, cultivators are better able to create a sustainable flow of mushrooms to supply the market. Members can split the transport costs, and the cost burden to the individual farmer is decreased. The cooperative can also be used to train members and can assist in empowering poorer growers in the community, including women.

Supporting services to help promote mushrooms as a source of livelihood

Various types of supporting services have the potential to improve conditions for small-scale mushroom growers and other producers, processors, farmers and traders. Some of these interventions are low level and practical, easily delivered by extension organizations undertaking project-based work with communities and small enterprises. Others are more over-reaching, including policy recommendations, and therefore rely on continued advocacy work by local, regional and national organizations. The two approaches are not mutually exclusive but will likely involve working with different people and over different time scales.

Support for community level mushroom cultivation can come from state or municipal governments, the private sector and, very frequently, NGOs. Successful interventions can have positive knock-on effects for other sectors, and often small changes result in large outcomes. Hence, direct assistance does not need to be about large financial investment, but rather it should encourage sustainable development based on local activities. Capacity building, increasing technical skills, encouraging innovation and resourcefulness, can all guide small-scale producers into the business world.

Public policy

The fundamental prerequisites for enabling small-scale producers to improve their livelihoods through agricultural, horticultural and small business activities are public goods, such as roads, electricity, telecommunications, rural markets and other infrastructure. Public investments therefore have an impact on people's capabilities to carry out activities, and investment in rural education, health, transport and communication infrastructure, and skills development, will impact on individual capabilities. As their capabilities increase, so does efficiency, while costs, risks and vulnerability reduce.

Some of the interventions on behalf of the government which can support successful mushroom cultivation activities at the policy level include:

- implementing rural livelihood support policies which cut across a traditionally narrow focus on one sector (such as agriculture, or livestock, or forestry), and instead support rural farmers to implement diversified livelihood strategies;
- developing specific policies to help promote trade, branding, food standards, etc. in horticultural products and, in particular, mushrooms;
- developing incentives for lending institutions to give credit to small or community run businesses, and make credit provision accessible to the rural poor and small-scale entrepreneurs.

Technical support and training in cultivation and processing

A level of technical guidance and support will be beneficial to most mushroom growers, particularly in the initial stages of cultivation, as many of the technical terms and procedures relating to mushroom cultivation may be unfamiliar to potential growers. Growers need to be familiar with fungi life cycles, and the importance of hygiene and sterilization in developing a successful growing system. Support may be required to improve cultivation techniques, access to appropriate varieties of spores, and post-harvest care, etc.

The most effective way to impart skills to the potential mushroom growers is to teach the fundamental aspects of the mushroom farming system and to provide hands-on training on site. Although requiring good planning and coordination, a very positive and practical way of providing this training is through Farmer Field Schools (FFSs). These provide an opportunity for learning-by-doing, based on the principles of non-formal education, with extension workers or trained farmers facilitating the learning process by encouraging farmers to discover key agro-ecological concepts and develop management skills through self-discovery activities practised in the field.

An alternative approach to training includes a study of market opportunities followed by community skills assessment and the provision of training on site, bringing trainers to the community rather than sending villagers to a training centre. This also allows other members of the family or community to benefit, learn the relevant skills, and become involved in the cultivation process.

Participation at national and international trade fairs can provide an opportunity to exchange information about overcoming challenges and improving cultivation and processing techniques, etc.

Business and entrepreneurial skills

Entrepreneurial skills are required if growers intend their cultivation activities to go beyond subsistence and local trade, and wish to develop a small business. These may include basic bookkeeping skills, planning and administration, management supplies of materials (sterilization equipment, and appropriate and timely quantities of substrate and spores), management and coordination of packaging and transport, and negotiation skills and marketing.

Market information

External assistance can help establish links and contacts for information on trends in product price, quantity and quality, understanding how market chains are structured and function, why similar mushroom cultivation initiatives may have failed or been successful. Additional training and support can then enable cultivators to use this information to their advantage.

Financial services

Fortunately small-scale mushroom cultivation does not require significant financial assets to establish an enterprise. Cash, savings and access to credit or grants are seldom essential to initiate small-scale cultivation systems, sufficient to provide a nutritious source of food and reliable source of instant cash. Financial resources will however become more important as the size of an enterprise scales-up, or if cultivators want to explore adding value through processing and consider investment in drying equipment, or secure specialist containers to package and transport products further to more distant markets.

The types of credit available vary between countries. Central and local governments and private organizations are normally good sources of credit for establishing farming business. Farmers will raise cash from farm gate sales or from agents or cooperatives marketing their produce. Cooperatives are often in a better position to offer credit to rural farmers than individuals or financial institutions.

External funding can be used to provide more efficient or high technological processing equipment, facilitate information and exchange visits, and provide training to expand cultivation skills.

Organizational options

Organization between cultivators to facilitate knowledge exchange, reduce vulnerability to shocks, and increase capacity to cultivate through

shared investment in equipment, helps reduce the vulnerability of individuals. If producers are specifically interested in trading mushrooms, organization can also help achieve a consistent, better quality and larger volume of supply, and collective or shared transport costs can help overcome the challenges of trading a perishable good.

Company-community partnership can take various forms including collaboration with companies or organizations which provide credit and technology. For example, a partnership arrangement may exist between a mushroom wholesaler and a number of smaller cultivation units who supply the wholesaler in return for technical and financial assistance.

Role of advisor

In conclusion, the following steps may be considered when planning a programme of assistance to rural farmers and villagers in mushroom growing:

- selecting the mushroom varieties that are appropriate to the location of the village and market demand;
- training government and private sector extension personnel in good agricultural practices;
- training farmers and villagers in their localities;
- setting up a pilot demonstration farm in the village;
- providing access to spawn and basic equipment required for growing mushrooms;
- conducting field days on practical methods of growing mushrooms for the benefit of potential mushroom growers in the villages;
- providing advice on mushrooms marketing and obtaining market links to local and distant markets;
- assisting in setting up cooperatives or producer groups for the benefit of all the villagers in accessing finance, continuing education to improve farming skills and obtaining market links to local and distant markets.

Opportunities and challenges

Opportunities

Mushrooms can play an important role contributing to the livelihoods of rural and peri-urban dwellers, through food security and income generation. Mushrooms can make a valuable dietary addition through protein and various micronutrients and, coupled with their medicinal properties, mushroom cultivation can represent a valuable small-scale enterprise option.

Mushrooms can be successfully grown without access to land, and can provide a regular income throughout the year. Growing mushrooms also helps avoid some of the challenges facing collectors of wild fungi, including species identification, obtaining access and permits for collecting, and practicing sustainable harvest. Cultivation is also independent of weather, and can recycle agricultural by-products as composted substrate which, in turn, can be used as organic mulch in growing other horticultural crops, including vegetables.

Mushroom cultivation is highly combinable with a variety of other traditional agricultural and domestic activities, and can make a particularly important contribution to the livelihoods of the disabled, of women and the landless poor who, with appropriate training and access to inputs, can increase their independence and self-esteem through income generation.

However, any interventions to promote livelihood activities should be carefully planned, and it is important at the outset to agree with potential mushroom growers: cultivation objectives and the skills, assets and resources available, as well as to identify what market opportunities exist, should they wish to trade their harvested crop. Successful mushroom cultivation for trade requires a good level of individual or collective organization, and although mushroom cultivation can be a viable small-scale business, any investment in a growing scheme can be risky.

Cooperatives and community groups can collaborate in set-up and production costs, harvesting and marketing. Working in joint ventures or partnerships with regional agro-industries, universities or wholesalers can help reduce vulnerability and

risk for small-scale producers, and provide access to training and other forms of support.

Challenges

Establishing larger scale mushroom cultivation systems can be more labour and management intensive. All production systems, to some extent, are vulnerable to sporadic yields, invasions of 'weed' fungi, insect pests, and unreliable market prices for traded goods. Moving from cultivating mushrooms for subsistence use to commercial production and marketing can be quite challenging to local growers. One of the most important aspects of growing mushrooms for commercial purposes is the ability to maintain a continuous supply for chosen market outlets, and if the mushroom enterprise is one of many livelihood activities, producers need to become multi-skilled to manage several enterprises successfully.

The initial challenges which mushroom growers have to face include determining the most suitable mushroom to grow and identifying a spawn supplier, organizing available resources to develop a growing system, and assessing requirements for supplying different marketing outlets. In spite of these, starting with home production is an advisable approach.

Some mushrooms have been given bad press because of poisonings, which fortunately are generally rare and have been associated with events, including: young children collecting indiscriminately and eating raw mushrooms; immigrants arriving in a new country and incorrectly identifying a local species that turns out to be poisonous; food shortages and economic hardship forcing people to hunt for food; and different physiological responses to an 'edible' fungus. Other health risks can include allergies to different mushroom spores.

Mushrooms have not often been actively promoted in the past by agricultural ministries of developing countries. Various reasons have been cited for this neglect, including: a lack of technical capacity in production techniques with poorly equipped government supported advisory services resulting in interested farmers having to seek technology on their own; comparatively few studies on tropical mushrooms; and a lack of technical skills to produce spawn with suitable strains often hard to find. The market can present an additional constraint in some regions as the prices of mushrooms are out of the range of most local consumers and unable to compete with other protein sources like beef, beans or eggs for a place in the average family diet.

In conclusion, many of the challenges which face mushroom cultivation activities are not uncommon to other challenges still faced by small-scale rural producers. As a livelihood diversification option, mushroom cultivation has enormous potential to improve food security and income generation, which in turn can help boost rural and peri-urban economic growth.

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Sources of further information and support

Food and Agriculture Organization of the United Nations (FAO)
Information Network on Post-Harvest Operations (In*P*ho)
www.fao.org/inpho

Post-harvest handling and processing of mushrooms, plus the cookbook section contains some mushroom-based recipes.

National Sustainable Agriculture Information Service (ATTRA)
http://attra.ncat.org/new_pubs/attra-pub/mushroom.html?id=other

International Mushroom Society
2306 Phaholyothin Road, Bangkhen, Bangkok 10900, Thailand
Tel: +662 579 4418
Fax: +662 561 2591

The organization provides study tours of mushroom farms, on job training, provides expertise and equipment and prepares project proposals.

International Mushroom Society of the Tropics
c/o Department of Biology
The Chinese University of Hong Kong
Tel: +852 609 6286
Fax: +852 603 5646

Ghana Export Promotion Council
P O Box M146
Accra
Ghana

The Ghana Export Promotion Council in collaboration with the Food Research Institute has been driving Ghana to become a major exporter. They set up the Natural Mushroom Development Project (NMDP) which has established a pure cultivation bank and involved in the production of pure spawn and runs training courses for commercial growers.

Scientific and Industrial Research and Development Centre (SIRDC)
P.O. Box 6640, Harare, Zimbabwe
Tel: +263 4 860321/9
Fax: +263 4 860350/1
info@sirdc.ac.zw
http://www.sirdc.ac.zw/

The Biotechnology Research Institute (BRI) of the Scientific and Industrial Research and Development Centre (SIRDC) produces and supplies high quality mushroom spawn in Zimbabwe. BRI also provides the supporting services for mushroom growing, e.g. training and consultancy. At the moment, oyster mushroom spawn (Pleurotus sajor-caju and P. ostreatus) is being produced.

Federal Institute of Industrial Research (FIIRO), Oshodi, Nigeria
P.M.B. 21023, Ikeja, Lagos, Nigeria
Fax: 234 1 4525880, Tel: 234 1 8947094
info@fiiro-ng.org
http://www.fiiro-ng.org/mushroom-production.htm

There are a number of commercial spawn producers around the world, but sustainable mushroom cultivation relies on the identification of a local reliable manufacturer of quality spawn. Information regarding these spawn suppliers can be obtained from the mushroom grower associations in different countries, but a useful starting point, if no contacts are known, are the following two international societies:

International Society for Mushroom Science
PO Box 11171, South Africa
secretary@isms.biz
www.isms.biz

World Society for Mushroom Biology and Mushroom Products
http://www.worldmushroomsociety.com

Notes

THIS BOOKLET HIGHLIGHTS THE MANY OPPORTUNITIES TO, AND BENEFITS OF, INCREASING FOOD AND INCOME SECURITY THROUGH INCORPORATING MUSHROOM CULTIVATION INTO LIVELIHOODS STRATEGIES. Mushrooms are fast yielding, provide for nutritious food and can provide a source of income. Cultivation does not require any significant capital investment or access to land, as mushrooms can be grown on substrate prepared from any clean agricultural waste material. It can be carried out on a part-time basis, requires little maintenance and is a viable and attractive activity for rural, peri-urban and urban dwellers, in particular women and people with disabilities. Through the provision of income and improved nutrition, successful cultivation and trade in mushrooms can strengthen livelihood assets, which not only reduce vulnerability to shocks, but enhance an individual's or a community's capacity to act upon other economic opportunities.

This booklet addresses what to do and how to promote sustainable development of mushroom cultivation for the benefit of the poor. It is aimed at people and organizations providing advisory, business and technical support services.

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