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Mushroom Cultivation – Ethiopia

GENERAL INFORMATION

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- ❖ **Implementation Period:**
The project was initiated in 1993 and commercial production of mushrooms started in 1997.
- ❖ **Costs:**
The total cost of the research project and pilot phase was \$7,500, of which \$2,500 was provided by the Ethiopian Science and Technology Agency and \$5,000 by the Africa Mushroom Company.

SUMMARY

Mushroom cultivation is a new activity in Ethiopia. As well as being a method of bioconversion of non-edible plant biomass into nutritious food, mushrooms are a cash crop, the market for which is growing worldwide.

While wild mushrooms are harvested in forests in Ethiopia during the rainy season, they are not a staple part of the diet and were not cultivated previously. Research on mushroom cultivation in Ethiopia started in 1993 at the Department of Biology, Addis Ababa University. Agricultural and agro-industrial waste and other cellulose-rich materials available in the country were investigated for production of the three most commonly cultivated mushrooms: *Agaricus bisporus* (button mushroom), *Pleurotus ostreatus* (oyster mushroom) and *Lentinula edodes* (shiitake mushroom). Appropriate methods of spawn production, substrate preparation, composting and mushroom growing under existing environmental conditions have been achieved.

The outcomes of the research project undertaken in the Department of Biology have provided the basis for the establishment of small-scale commercial mushroom enterprises in and around Addis Ababa. The most successful of these, the Africa Mushroom Company, is the first private enterprise to supply fresh edible mushrooms to the Addis Ababa market throughout the year. The company has gradually gained experience in the

technology of cultivation as well as the training of technicians capable of managing the mushroom farm. The waste generated, the spent compost, is used as organic fertilizer for growing vegetables and tree seedlings. This project has shown that sustainable and environmentally friendly small-scale mushroom production is feasible in Ethiopia.

BACKGROUND AND JUSTIFICATION

World production of cultivated edible mushrooms is estimated to be almost 5 million tonnes, valued at about \$9.8 billion per year, to which Africa contributes a very small proportion. Total global production of mushrooms has increased more than tenfold in the past 25 years and the market for mushrooms is growing. The production of mushrooms, therefore, has the potential to generate a significant cash income.

Mushrooms are a nutritious food source, being rich in protein, vitamins and minerals. They are also known to contain substances that enhance the immune system, fight infectious diseases, and lower blood pressure and cholesterol levels.

Mushrooms can be cultivated on a variety of substrates, including agricultural and agro-industrial waste materials such as cereal straw, grass straw, cotton waste, corn cobs, bagasse (the biomass remaining after crushing of sugarcane or sorghum stalks for juice extraction), coffee waste, sawdust, animal dung,

chicken manure and brewers' spent, which are abundant in sub-Saharan Africa, a predominantly agricultural region. Mushroom growing is a means of converting such non-edible biomass into food. The waste products of mushroom cultivation (spent compost) can also be used as organic fertilizer for growing vegetables and developing tree nurseries.

The prevailing mild temperatures in Ethiopia, particularly in the highlands, are conducive to mushroom growing. Although the low level of relative humidity during most of the year is not optimal for cultivation, this is a problem that can be dealt with by using appropriate environmentally sustainable methods of moistening the air. The area of land required for cultivation is small, as mushrooms do not need light for growth and they are commonly produced on shelves indoors. Thus mushrooms can be produced and harvested throughout the year with relatively little investment.

Although mushrooms form part of the African diet, the potential for small-scale production has not yet been realized. The Department of Biology of Addis Ababa University initiated a three-year project on mushroom cultivation in 1993. The main objective of the project was to identify appropriate types of mushroom for cultivation in Ethiopia; evaluate the usefulness of different, readily available substrates; develop methods for spawn production; and construct suitable, simple growing houses for small-scale mushroom cultivation. The next step of the venture was dissemination of

the results of research activities and the organization of training activities under the auspices of the Ethiopian Society for Appropriate Technology (ESAT). A few small-scale mushroom enterprises were established. The example of the Africa Mushroom Company is presented as a model for small-scale mushroom enterprises and to show that mushroom growing can be a feasible, sustainable and environmentally sound socio-economic activity in Ethiopia and elsewhere in Africa.

DESCRIPTION

THE TECHNOLOGY OF MUSHROOM CULTIVATION

Research focused on the cultivation of the three most commercially important mushrooms: the button mushroom (*Agaricus bisporus*), the shiitake mushroom (*Lentinula edodes*) and the oyster mushroom (*Pleurotus ostreatus*). Mushroom cultivation has four important components: spawn production, substrate preparation, mushroom (fruiting-body) production and the management of mushroom houses.

Mushroom Spawn Production

The major constraint to mushroom production in Africa has been the lack of spawn, the vegetative "seed" of mushrooms. Spawn suppliers (enterprises) did not exist in Africa and obtaining quality spawn from abroad is expensive and technically difficult. The first activity of the project was, therefore, to develop the capacity to produce spawn for various cultivated mushrooms.

Spawn (fig. 1) is made from pure cultures of mushrooms transferred to sterile moist grain, such as wheat, millet or sorghum. Culture propagation and spawn-making require a modest laboratory facility for the preservation of selected cultures, sterilization of agar media and grain in bottles, a clean bench for aseptic handling, a refrigerator and an incubator.



Figure 1 | Mushroom spawn in bottles.

Substrate Preparation and Mushroom Growing

The yield of mushrooms depends on the type of substrate used, the method of preparation and the suitability of environmental conditions (temperature and humidity) for growth and fruiting-body formation. Therefore, once the capacity to produce quality (uncontaminated) spawn had been established, the emphasis was shifted to an evaluation of potential substrates. A survey of potential raw materials and their availability was carried out.

It was found during the project that oyster mushrooms were by far the easiest and least expensive mushroom to grow. They are fairly resistant to environmental changes and few other mushrooms demonstrate such adaptability, hardiness

and productivity. They grow on a wide array of otherwise unused forest and agricultural wastes from farms, plantations and factories although a mixture of cotton-seed waste, wheat bran and chalk gave the best results. The substrate can be placed in boxes, plastic bags or even in common household items such as traditional clay pots (fig. 2). After harvesting, the decomposed substrate can be used for soil conditioning. For small cultivators with limited budgets, oyster mushrooms are the clear choice for gaining entry to the mushroom market.

The button mushroom accounts for about 50 per cent of the mushrooms produced worldwide. Unlike the other mushrooms mentioned in this case study, the button mushroom grows on composted substrate, which is made by mixing, piling and composting teff (*Eragrostis tef*) straw, horse dung and chicken manure. The composition of the compost must be monitored and adjusted. Although the raw materials are readily available (teff straw is the most abundant cereal straw in the Ethiopian highlands), the cultivation



Figure 2 | Oyster mushrooms grown in a traditional clay pot.

of the button mushroom is more complex than that of other mushrooms.

Demand for the oldest cultivated mushroom, the shiitake, is growing worldwide and it has gradually become one of the most important exotic mushrooms in North America. Research showed that this mushroom can be cultivated on a variety of tree logs as well as on sawdust-based substrates incorporating cotton-seed waste, which is readily available in Ethiopia.

MANAGING THE MUSHROOM FARM

The main activities of a mushroom farm are culture preservation and spawn-making, substrate preparation, spawn-running, casing-watering, hygiene (maintaining standards of cleanliness to minimize the incidence of pests or diseases), harvesting/packing and supplying mushrooms to the market.

Construction of Growing Facilities

Since mushroom-growing facilities (especially for button mushrooms) may require considerable investment because of the need for regulating the growing environment, one of the aims of this project was to construct simple, low-cost mushroom houses that would be made from local materials and suitable for the cultivation of mushrooms throughout the year (fig. 3).

The optimal design was shown to be houses constructed from bamboo and other plant materials. Direct sunlight is excluded, the walls and ceiling are lined with plastic sheets in order to maintain



Figure 3 | A simple mushroom-growing house made from locally available materials, including bamboo.

humidity, and mushroom cultures are placed on wooden shelves.

Harvesting and Preservation of Mushrooms

Mushrooms are perishable, with a relatively short shelf-life, so they are best supplied to market soon after harvesting (fig. 4). When storage is required, the easiest and least expensive method of preservation is by sun-drying. However, button mushrooms are best preserved by pickling or canning.



Figure 4 | Packing fresh mushrooms in paper boxes and baskets.

Diseases and Pests of Mushrooms

One of the most challenging activities of a small-scale mushroom farm is to control the diseases and pests of mushrooms, such as various species of mould, weeds, bacterial blotch and, most damaging of all, mushroom flies. Good management practices and strict hygiene can reduce these problems.

Spent Mushroom Substrate

Used or "spent" substrate is a highly organic material that can be used on vegetable and flower gardens and tree nurseries and may be promoted for sale in the future.

DISSEMINATION AND APPLICATION OF RESEARCH RESULTS

Results from the research phase of the project were found to be promising and showed that it was possible to cultivate the three types of mushroom on a small scale.

The publication in local newspapers of information derived from the research generated interest in growing mushrooms among individuals and non-governmental agencies, such as Environmental Development Action in the Third World (ENDA), Ethiopia. A manual, *Mushroom Cultivation: A Practical Approach*, was published by the author of this case study in 1998. A training course designed for women and unemployed young people was developed and organized in cooperation with the Ethiopian Society for Appropriate Technology (ESAT). The three-month training course, financed by Henrich Böll Stiftung (Germany) and

managed by ESAT, was intended to enable young people to initiate small-scale mushroom cultivation efforts independently in Ethiopia.

MUSHROOM-GROWING ENTERPRISES: THE EXAMPLE OF THE AFRICA MUSHROOM COMPANY

Before embarking on production, the Africa Mushroom Company established a spawn-making facility. The spawn unit is managed by two trained technicians and produces a total of about 7,800 bottles per year of three types of mushroom spawn. Twelve individuals are employed in the management of the mushroom farm, which includes five mushroom-growing houses, a store and a substrate-preparation room. Staff are employed in substrate preparation and composting, cleaning of mushroom houses, harvesting and packing. A driver is responsible for transporting raw materials to the farm and mushrooms to market. A guard takes care of the farm property. A manager is responsible for production, marketing and profitability. The manager is supported occasionally by a technical adviser from the mushroom research group in the Department of Biology of Addis Ababa University.

Wherever possible, the Africa Mushroom Company tackles pest-control problems without synthetic pesticides. Spent substrates are used to make a casing material for button mushrooms and as a fertilizer for the company vegetable garden and vegetable and flower growers in the vicinity.

PATENTING AND COMMERCIALIZATION

Research, training and development of mushroom growing in Ethiopia have provided the basis for small-scale commercial production of mushrooms, which are sold to supermarkets, hotels and restaurants in Addis Ababa. No patents have resulted from the outcomes of the research.

PARTNERSHIPS

The Ethiopian Science and Technology Agency supports mushroom-growing workshops and training activities. Addis Ababa University undertakes research and publicizes the outcomes to stakeholders, including mushroom growers.

REPLICABILITY

The raw materials to grow mushrooms (cellulose-rich agricultural and agro-industrial waste) are abundant in Africa. While environmental conditions such as temperature and humidity differ geographically, production techniques can be adapted to local conditions so that mushrooms can be grown throughout the year.

The experiences and outcomes of this project could be replicated in other regions and countries of Africa via the organization of short-term training courses.

The initial investment required to establish a commercial enterprise varies

according to the number of types of mushroom to be cultivated and the market. The Africa Mushroom Company has a very limited capacity to supply mushroom spawn to the rest of the country; thus independent spawn enterprises are now being established to cater to this need.

IMPACT

Mushroom growing is an activity that can create jobs and help to generate cash income. It is environmentally friendly and the by-products can be recycled or used for other agricultural purposes.

Training and technical support to growers can significantly help the transfer and adoption of the technology of mushroom production. With the support of research and training, mushroom production could have a significant impact on poverty alleviation and food security in Africa.

Mushroom growing represents an employment opportunity for jobless people and cash generation for growers. Moreover, the development of a value chain comprising spawn producers, suppliers of substrates (raw materials), mushroom growers and supermarkets is gradually taking shape. Some of the trainees of the Ethiopian Society for Appropriate Technology were employed by the emerging mushroom enterprises. Others are looking for financial support to establish themselves as mushroom growers.

LESSONS LEARNED

Mushroom cultivation requires expertise in the techniques of spawn-making, substrate preparation, composting, pest control, harvesting and packing. Without this knowledge base, mushroom cultivation would fail. Training courses for growers and technicians must be provided. Courses tailored to individuals ready to start businesses and to those who can provide technical support to such enterprises must be offered and publicized.

FUTURE PLANS

The mushroom is not a traditional crop in Ethiopia or in Africa in general and the low level of research and training in mushroom cultivation is the main problem hampering the development of mushroom production. Regional training courses tailored to mushroom growers, spawn technicians and agricultural extension workers are planned. Appropriate books and practical manuals are also urgently needed. In the near future, a manual will be published in Amharic.

There are also plans to translate the results and experiences obtained from small-scale commercial cultivation to larger and more environmentally controlled production systems with facilities for the export market.

PUBLICATIONS

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