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Agro-Industry Development in a Peripheral Region: The Galilee Mushroom Industry Case Study

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Abstract

Agricultural settlements at Israel's mountainous northern border have long faced constraints related to limited land and water resources. Edible mushroom cultivation requires minimal land and relatively low water inputs and was identified as a suitable agro-industrial activity for the region. Therefore, national settlement institutions initiated the establishment of mushroom farms based on Dutch cultivation technologies and guidelines. Approximately 25 small-scale farms, each consisting of two to three growing rooms, were established, together with a centralized compost production and marketing infrastructure serving the entire region. Production focused on the white button mushrooms (*Agaricus bisporus*); however, most crops failed, due to lack of uniformity and quality of the compost resulting in economic losses and the closure of most farms. These failures highlighted the need for locally adapted applied research. In response, the Israeli Ministry of Agriculture commissioned the National Agricultural Research Institute (Volcani Institute) to establish a dedicated research program. For this purpose, a research group was established by the Northern R&D organization at MIGAL-Galilee Research Institute. The group facilities included a research center at MIGAL in Kiryat Shmona, and a quality control and service laboratory and extension located at the regional infrastructure. This group's applied research addressed key production bottlenecks mainly the quality and uniformity of the compost, and continued R&D efforts to improve efficiency. The group's extension held close collaboration with the growers that facilitated the implementation of research findings in commercial production. The results of the research and their implementation by the producers led to professional and technological improvements that increased output per area unit from 65 kg/m^2/year (1980) to 270 kg/m^2/year, currently, and enabled the industry in the north to grow and establish itself as the center of

mushroom cultivation in Israel, and serve as a major source of employment and livelihood in the Galilee. This progress was achieved without any specific government subsidy for this industry.

Keywords

Peripheral Region Development, Applied R&D, Extension, Mushroom Industry, Economic Growth

1. Introduction

The establishment of the Northern R&D Center towards the end of the 20th century was part of a national effort to disperse the population and strengthen agriculture in peripheral areas. To achieve this goal, agricultural R&D centers were established in several peripheral areas where agriculture is a major source of employment and livelihood (Levanon & Degani, 2025). The primary mission of the Northern R&D Center was to develop agriculture in the mountainous areas of the country's north. Developing agriculture in these areas encountered two main difficulties: Shortage of water and the high cost of bringing it to the mountains; Shortage of suitable land for agricultural cultivation and the high cost of clearing stones in land preparation.

With the establishment of Northern R&D, a survey was conducted on new agricultural crops suitable for the mountain areas in the north of the country and on the status of existing crops. This survey found that several years earlier, about 25 mushroom farms had been established in these areas. Mushroom cultivation is perfectly suited to deal with the two main limitations of mountain agriculture: It does not require agricultural land, and its water consumption is minimal compared to other crops. The team that planned the establishment of the mushroom industry in the Galilee relied on knowledge from the Netherlands, which was a leading country in this industry. Therefore, the construction of the cultivation rooms and cultivation methods, were according to the Dutch knowledge. A centralized compost production facility and marketing infrastructure for the entire region's mushroom farms were established and operated by the local farmers' organization. Production of white button mushrooms (*Agaricus bisporus*) started but since its beginning, most crops failed, resulting in economic losses that led to closure of most of the farms. These failures highlighted the need for locally adapted applied research to examine the reasons for these failures and develop ways that will enhance successful cultivation. In response, the Israeli Ministry of Agriculture commissioned the National Agricultural Research Institute (Volcani Institute) to establish a dedicated research program for this purpose. This Institute decided that the mushroom research effort will be a part of the Northern R&D organization at MIGAL-Galilee Research Institute (Degani & Levanon, 2025).

2. Organization and Structure

To accomplish this task, a dedicated mushroom cultivation research unit was constructed. The unit included three small mushroom cultivation chambers with full climate control including equipment for: temperature, humidity, lighting, CO_2 control. The unit was constructed near MIGAL's chemistry and microbiology research laboratories at Kiryat Shmona. The fact that this research institute already had active laboratories for chemistry and microbiology greatly assisted in organizing the research team on mushroom cultivation, as these fields are necessary in this type of research. Another quality control and service laboratory was established near the central compost production facility close to the mushroom cultivation farms, to carry out ongoing quality control of the compost production.

The research group that was built included M. Sc. and Ph. D. students from the Faculty of Agriculture of the Hebrew University of Jerusalem who conducted their thesis research with the Galilee mushrooms research team. It was decided to appoint to the group a researcher whose role would be to lead the composting control laboratory, monitor compost production and transfer knowledge from the research group to the mushroom growers. As part of his role, he closely monitored the development of this industry, its needs, and the latest technology that suits it. This researcher moved to live in a community close to the compost production plant. This step proved to be of crucial importance in creating a connection between the research group and the compost producers and mushroom growers. Within this framework, the needs of the growers were transferred to the research team, and the results from the research group and other knowledge gathered were transferred to the growers (Degani, Levanon, & Yom Din, 2021).

3. Research Priorities

3.1. Improving Compost Production for Successful Mushroom Cultivation

The research team searched for what could be the main reasons for the failures in the region's mushroom cultivation. Since the growth chambers provided suitable growing conditions, it seemed that they were not the cause. On the other hand, the production of compost was based on different raw materials from those in Europe. In Europe and the United States, the main component of mushroom cultivation composts is horse manure, which is not found in sufficient quantities in Israel. The compost produced in Israel is based on broilers manure mixed with wheat straw and gypsum. Since the compost production was carried out in open-air windrow piles, the very different climate in Israel compared to Northern Europe must also have had an impact. On the other hand, the nutritional needs of the mushrooms that the compost must provide depend on the mushroom species, regardless of where it grows.

Therefore, the research team priority determined to start with the study of: Chemical, physical and biological parameters for the quality control of compost production (Levanon, Dosoretz, & Motro, 1983). This study was conducted in col-

laboration with the compost production plant, and its results helped the plant adapt the production protocol to the required compost composition. The participation of the researcher located at the compost production site enabled direct contact between the research team and the composting plant and subsequently helped the plant to improve compost production systems and technologies.

3.2. Recycling of Waste for Mushroom Substrates and Spent Mushroom Cultivation Substrates

Edible mushroom cultivation is carried out through organic materials utilization, most of which are agricultural, forestry, and gardening wastes. Using these materials allows the recycling of waste for food production, reducing environmental pollution and carbon emissions. In addition to compost, the main material for growing *Agaricus bisporus* mushrooms is the casing soil. It consists mainly of peats. Peat is mined in peatlands, found mainly in northern European countries. Peat bogs are a large reservoir of fixed carbon and therefore mining them means releasing carbon into the atmosphere. Therefore, efforts have been made to reduce and even prohibit peat mining. At MIGAL, a research group, conducted long-term studies on recycling organic waste and generating biogas energy through anaerobic thermophilic fermentation. The solid slurry from dairy cattle manure fermentation has been tested for the use as peat substitutes in large-scale potted plants (vegetables and flowers) cultivation. The mushroom research team suggested exploring the possibility of using this slurry as peat substitute for casing soil in mushroom cultivation. The physical properties of this sludge, and especially the water holding capacity, are like those of brown peat and therefore it was demonstrated that it can be used as a peat substitute for mushroom casing also. Unfortunately, the use of this byproduct as a casing soil for mushrooms was discontinued after few years. The reason for this was the cessation of biogas production facilities in the dairy farms due to lack of economic viability (Levanon et al., 1984). At the same time, the production of edible mushrooms itself is accompanied by many organic residues that must also be properly handled. The chemical and physical composition of these residues, which include compost and casing soil residues, has been found to be suitable soil mulching material in Avocado plantations. It has been found that ground cover in plantations planted on heavy soil improves the growth of the roots of the plantation trees, thereby contributing to a quantitative and qualitative improvement in the crop (Danai et al., 2012).

3.3. Additional Types of Mushrooms for Production in Israel

Special efforts were invested in developing the cultivation of additional species of edible mushrooms. The goal was to diversify the mushroom products on the market and enable additional production for growers. As the first and main product during the expansion of the mushroom product basket, mushrooms of the *Pleurotus species* were chosen (Danai et al., 1987). These mushrooms were found to be more suitable than others for local climatic conditions. Growing these mush-

rooms allows for the recycling of waste and by-products from agriculture and forests that contain lignocellulose. A process was developed for growing these mushrooms on a mixture of wheat and cotton straw. To preserve the cotton straw for use throughout the year, a preservation method like that of preserving Corn for cattle feed as silage was developed (Silanikove et al., 1988). As part of the research project, a pilot plant was established in which the substrate for growing mushrooms was prepared. The substrate was inoculated with *Pleurotus spp*., inoculum packaged in bags and sent for cultivation in the in the agricultural settlements (Levanon et al., 1989). In further studies, other species were examined, including *Morchella species* (morel) and *Lentinula Species* (Shiitake) (Goldway et al., 2000; Danai et al., 2009).

3.4. Drip Irrigation in Mushroom Cultivation

During mushrooms (*Agaricus bisporus*) cultivation after covering the compost with a casing soil, it is necessary to irrigate the casing soil in which the mushroom grows to supply water to the developing mycelium and fruiting bodies. The conventional irrigation method is spraying water on the casing soil. This method has disadvantages, due to the need to stop irrigation at the beginning of the development of the fruiting bodies initials, since the sprayed water can harm the initials. Later, after the development of the fruiting bodies, wetting them may cause the development of diseases (mainly bacterial blotch), that harm the quality of the mushrooms. To deal with this problem, energy must be invested in drying the mushrooms. The mushroom research group at MIGAL in cooperation with NETAFIM industry developed a specific mushroom drip irrigation system to overcome these problems. Through the drip irrigation system water is supplied directly continuously to the casing soil layer, according to cultivated mushrooms needs and the mushroom's surface remain dry and clean of disease causes (Danay et al., 2017; Navarro et al., 2020).

4. The Outcomes

As a result of the professional crisis of the late 1980s, the Galilee mushroom industry contracted to approximately 12 growing rooms, each averaging 134 m^2 of cultivation area, with a total annual production of about 105 t. Over the subsequent four decades, the sector was fundamentally transformed through coordinated institutional support and sustained R&D leadership, particularly by regional research and extension frameworks centered around MIGAL. These efforts facilitated the professionalization of production systems, the diffusion of advanced cultivation technologies, and the consolidation of knowledge-intensive management practices. Consequently, the number of growing rooms increased more than elevenfold to approximately 137, while the average room size expanded nearly fivefold to about 635 m^2 with increased output per area unit from 65 kg/m^2/year (1980) to 270 kg/m^2/year. These structural and technological changes translated into a dramatic rise in output, reaching an estimated 15,000 t annually—an

increase of more than two orders of magnitude—and currently supplying approximately 75% of Israel's total mushroom consumption, which has grown significantly in recent years. Most mushroom consumption is of the white button mushrooms, and other mushrooms (*Pleurotus* spp., *Lentinula* spp. etc.) account for about 5% of the market volume. The annual revenue turnover of the Galilee mushroom industry is approximately 350 million shekels (approximately $100 million) and about 460 employees are permanently employed (Danai & Levkovitz, 2012). On this scale the Galilee mushroom industry is currently an extremely important source of livelihood and employment in the Galilee region. It is important to emphasize that this progress was achieved without any specific government subsidy for this industry (Israel Government resolution, 2017).

5. Concluding Note

This case study demonstrates that agro-industrial development in peripheral regions depends not only on technological transfer but on sustained, place-based applied research, extention and institutional proximity between researchers and producers. The Galilee mushroom industry illustrates how integrated research-extension frameworks can transform initial failure into long-term regional economic resilience.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Danai, O., & Levkovitz, G. (2012). *The Contribution of Research in the Mushroom Industry.* Office of the Chief Scientist, Ministry of Agriculture and Rural Development.

Danai, O., Cohen, H., Ezov, N., Yehieli, N., & Levanon, D. (2012). Recycling of Spent Mushroom Substrates (SMS) in Avocado Orchards. *Journal of Agricultural Science and Technology B, 2,* 1165-1170.

Danai, O., Ezov, N., Levanon, D., & Masaphy, S. (2009). Introduction of New Exotic Mushroom Species into Cultivation in Israel. *Israel Journal of Plant Sciences, 56,* 295-301. https://doi.org/10.1560/ijps.56.4.295

Danai, O., Levanon, D., & Silanikove, N. (1987). Cotton Straw Silage for Pleurotus Production in Commercial Scale. *Mushroom Information, 12,* 2-3.

Danay, O., Van den Berg, P., Raz, D., Engel, Y., Kobi, E., Barski, I., & Levanon D. (2017). From Theory to Practice—Success in Implementing Drip Irrigation in Commercial Mushroom (*A. bisporus*) Cultivation. *Mushroom News, 65,* 4-7.

Degani, G., & Levanon, D. (2025). Development of an Applied Academic Research Institute by a Group of Researchers from Various Disciplines, with the Overarching Goal of Advancing Science in a Peripheral Region. *Open Journal of Applied Sciences, 15,* 2568-2575. https://doi.org/10.4236/ojapps.2025.159171

Degani, G., Levanon, D., & Yom Din, G. (2021). Academic Research, Higher Education, and Peripheral Development: The Case of Israel. *Economies, 9,* Article 121. https://doi.org/10.3390/economies9030121

Goldway, M., Amir, R., Goldberg, D., Hadar, Y., & Levanon, D. (2000). *Morchella conica*

Exhibiting a Long Fruiting Season. *Mycological Research, 104,* 1000-1004. https://doi.org/10.1017/s0953756200002598

Israel Government Resolution (2017). *Resolution on Economic Development of the Northern District and Complimentary Steps for the City of Haifa.* Israel Government Resolution.

Levanon, D., & Degani, G. (2025). Scientific Research and Higher Education as a Lever for Bottom-Up Regional Development—The Case of the Upper Galilee, Israel. *Journal of Biotechnology and Biomedicine, 8,* 97-101. https://doi.org/10.26502/jbb.2642-91280182

Levanon, D., Danai, O., & Silanikove, N. (1989). Cotton Straw Silage as Substrate for *Pleurotus* sp. Cultivation. *Mushroom Science, XII,* 81-90.

Levanon, D., Dosoretz, C., & Motro, B. (1983). Chemical and Biological Qualification of Composts for Mushrooms (*Agaricus bisporus*). *Mushroom News, 31,* 16-19.

Levanon, D., Dosoretz, C., Motro, B., & Cohen, I. (1984). Recycling Agricultural Wastes for Mushrooms Casing. *Mushroom Journal, 133,* 13-17.

Navarro, M. J., Gea, F. J., Pardo-Giménez, A., Martínez, A., Raz, D., Levanon, D., & Danay, O. (2020). Agronomical Valuation of a Drip Irrigation System in a Commercial Mushroom Farm. *Scientia Horticulturae, 265,* Article ID: 109234. https://doi.org/10.1016/j.scienta.2020.109234

Silanikove, N., Danai, O., & Levanon, D. (1988). Composted Cotton Straw Silage as a Substrate for *Pleurotus* sp. Cultivation. *Biological Wastes, 25,* 219-226. https://doi.org/10.1016/0269-7483(88)90081-x