Global mushroom cultivation is becoming larger in scale and more automated

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Contents

Summary

Global mushroom production and consumption remain relatively stable, though there are notable differences between countries and mushroom types. China's production and growth rate for a diverse range of mushrooms are unprecedented, while production of common button (Agaricus) mushrooms is declining in the Netherlands, the US, and Australia.

Mushroom cultivation is consolidating into fewer – but larger – operations to improve quality, consistency, and cost efficiency.

Automation, especially robotic harvesting, is advancing rapidly due to labor shortages and cost pressures, with technology readiness levels nearing commercial viability.

Sustainability requirements are also driving the shift toward larger-scale companies. A key sustainability concern in the mushroom industry involves the peat used in casing soil for cultivated Agaricus mushrooms. Life-cycle assessments could enable growers and suppliers to anticipate changes in cultivation methods and adapt accordingly.

As the mushroom industry faces a stagnant market, stricter sustainability requirements, and labor challenges, it is transitioning toward greater consolidation with more vertical integration and automation. Increased collaboration across the sector could help to encourage consumption and speed up sustainability efforts.

Mushroom markets outside Asia remain relatively stagnant

According to the Food and Agriculture Organization of the United Nations, global production of edible mushrooms – excluding China – amounted to 2,668,307 metric tons in 2014 and increased to 2,988,078 metric tons in 2024 (see figure 1). This represents a compound annual growth rate (CAGR) of 1.1%, which is in line with global population growth but did not outperform it. This modest increase in production suggests a corresponding stagnation in consumption levels. Despite the improved availability, relative affordability, and well-documented health benefits of mushrooms, as well as the increasing prevalence of vegetarian and flexitarian diets in some producing countries, these developments have not yet resulted in higher overall consumption.

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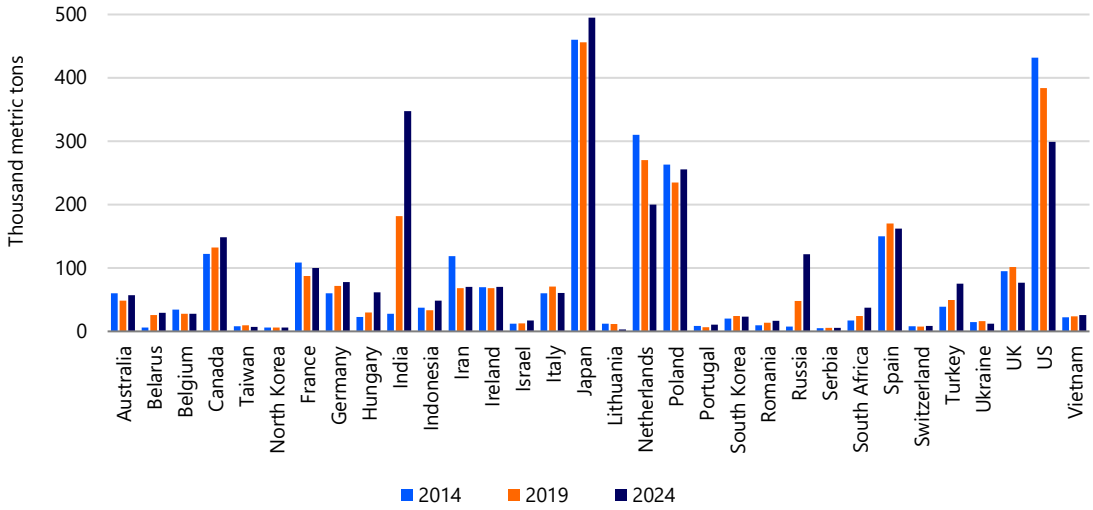
Figure 1: Global mushroom production is stable, but there are significant differences across individual countries,* 2014-2024



*Note: Figure includes countries (except China) that produced more than 5,000 metric tons of mushrooms in 2024.
Source: FAOSTAT, RaboResearch 2026

Over the past decade, a few countries saw notable growth in mushroom production, most prominently India and Russia. In India, large-scale commercial mushroom cultivation has become firmly established, including both Agaricus and other types. In Russia, production growth seems to have been largely associated with a ban on mushroom imports implemented about 10 years ago.

Other countries have experienced a pronounced decline in production, notably the Netherlands, the US, and Australia. In the Netherlands, production destined for industrial processing – particularly for canning and glass packaging – has come under increasing pressure. As fresh mushrooms become more widely available in destination markets, consumer preferences have shifted away from processed products, contributing to reduced purchasing at the retail level. The decline in US production, on the other hand, reflects slightly lower consumption levels and rising imports, as several large companies that are active in the US also operate composting and production facilities in Canada or Mexico.

Australian mushroom consumption is declining, leading to a decrease in production that began after 2021. Bad publicity around wild mushrooms appears to be one of the contributing factors. The Australian example raises an important question for the global mushroom industry: Are commonly cited growth drivers, such as health attributes, sufficient to maintain demand, or do perception, trust, and communication play a far greater role than is often acknowledged? Marketing initiatives aimed at improving Agaricus consumption – such as those launched by Groupement Européen Producteurs de Champignons (GEPC) in Europe, the Mushroom Council in the US, and the Australian Mushroom Growers Association (AMGA) – may find an answer to that question.

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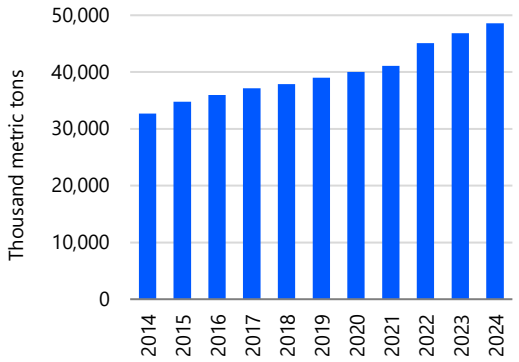
China's scale of production and pace of growth are unprecedented

The world's leading producer of mushrooms is not represented in the figure above. According to FAOSTAT, China accounts for approximately 94% of global edible mushroom production (see figure 2). This implies that per capita consumption in China has reached a level of between 25 and 30 kilograms annually. From 2014 and 2024, Chinese mushroom production expanded at a CAGR of 3%.

Figure 2: Mushroom production in China is rapidly increasing, 2014-2024



Source: FAOSTAT 2026, RaboResearch 2026

Although the accuracy of these statistics may be subject to scrutiny, multiple sources confirm that mushroom production – and consequently consumption – in China has increased substantially over the past decade. Moreover, production has increasingly shifted from hobbyist cultivation and smallholder farming as a supplementary source of income toward professionalized, very large-scale enterprises.

It should be noted that Agaricus mushrooms, such as white and brown button mushrooms, account for only an estimated 10% to 15% of China's total mushroom production. In Japan, the share of Agaricus is similarly limited, with estimates suggesting that it represents approximately 10% of overall mushroom production. By contrast, in the US, Poland, and the Netherlands, Agaricus mushrooms account for more than 90% of total production.

Specialty mushrooms show greater growth than Agaricus

Indeed, the cultivation of edible mushrooms in North America, Europe, and Australia and New Zealand consists almost entirely of button mushrooms. In contrast, Asian markets feature a much wider range of products, underscoring the potential for diversification to create new opportunities elsewhere. Important traded mushrooms in Japan include shiitake (Lentinus sp.), nameko (Pholiota or butterscotch mushroom), enokitake (Flammulina sp.), and shimeji (Hypsizygus sp.). The most important cultivated species in Taiwan is the oyster mushroom (Pleurotus sp.).

In contrast to the market for white button mushrooms, the market for specialty mushrooms (everything except button mushrooms) is steadily growing worldwide. Shiitake and oyster mushroom are the most common varieties, but enokitake and maitake (Grifola sp.) are also becoming increasingly popular.

Brown Agaricus gaining popularity, frequently using organic cultivation methods

Diversification into other mushroom species is challenging for established producers, as it typically requires different compost/substrate formulations and distinct cultivation systems. As a result, companies in Europe and North America have increasingly sought diversification within the Agaricus category itself, primarily by expanding the share of brown mushrooms in their production portfolios, sometimes through the use of organic cultivation methods. The proportion of brown mushrooms in total Agaricus production and consumption has been increasing in almost all regions worldwide. This trend is illustrated by rising sales of brown mushrooms in Dutch supermarkets and the increasing share of brown mushrooms in US mushroom producers' sales volumes (see figures 3 and 4).

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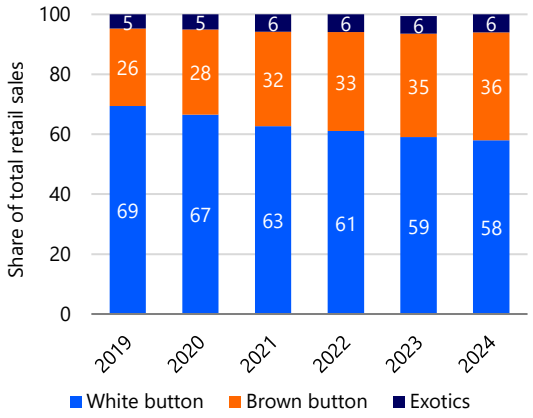
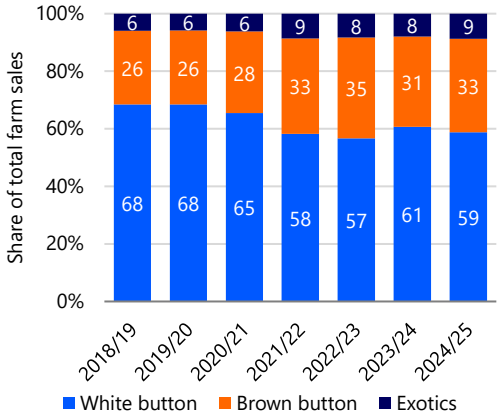
Figure 3: Mushroom types in Dutch retail, 2019-2024



Source: Circana, GroentenFruitHuis, RaboResearch 2026

Figure 4: Mushroom types in US production, 2018/19-2024/25



Source: USDA, RaboResearch 2026

Brown mushroom yields are approximately 10% to 15% lower per metric ton of fully grown compost or per square meter than those of white mushrooms. Thus, when mushroom companies decide to increase the share of brown mushrooms in their portfolio, achieving the same output volume requires larger quantities of compost and additional cultivation area compared to white mushrooms.

Economies of scale are driving changes in production practices

Mushroom cultivation is trending toward larger-scale operations across most regions globally. Large retail chains demand mushrooms with consistent quality, which is more easily achieved within a single, larger operation than by aggregating output from many small growers. In addition, achieving cost efficiency in the transport of inputs and final products requires high capacity utilization.

Increasing robotization will further reinforce economies of scale, as the high investment requirements for harvesting automation place smaller producers at a cost disadvantage relative to large-scale operations.

Furthermore, regulations aimed at preventing odor nuisance during composting or governing the discharge of wastewater are driving up indirect costs per enterprise, including investments in energy saving equipment, facility upgrades, and recurring expenses. Because these costs do not scale with production volume, larger farms are able to achieve lower unit costs.

Although scale enlargement also entails drawbacks – such as longer supply distances for inputs or greater vulnerability to disruptions – its advantages currently prevail, particularly within modern Agaricus production systems. As a result, the sector is undergoing several significant structural changes. Some are already underway, with others expected to materialize in the coming years.

Optimization of production processes at each stage of cultivation

As discussed, increasing an operation's scale enables more optimal design of composting and cultivation processes tailored to each phase in mushroom production.

Mushroom cultivation uses phase II or phase III substrate, depending on factors such as mushroom type, supply chain structure, and farm size. Agaricus production increasingly uses phase III compost. In this system, mycelial colonization usually takes place in tunnels, after which the compost is transferred to growing rooms – sometimes still in blocks or bags, but mostly arranged in racks and beds according to the Dutch shelf system or similar configurations.

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Due to the advantages of process control and economies of scale, compost incubation has increasingly become part of substrate producers' operations. It is estimated that approximately three-quarters of global button mushroom production now relies on phase III tunnel compost.

The substrate/compost producer and the grower may be owned by the same entity (vertical integration) or operate under separate ownership (horizontal supply chain specialization). In Europe, horizontal specialization is more common, whereas vertical integration predominates in most other regions of the world. However, vertically integrated models are also gaining ground in Europe.

Automation and robotics are becoming central to the future of mushroom cultivation

Automation and robotization are gaining momentum in mushroom production, driven by grower challenges, evolving industry demands, and technological development. In the longer term, more transformative production systems are likely to emerge.

Grower challenges and the changes driving automation

The greatest challenge currently facing Agaricus mushroom growers is harvesting mushrooms for the fresh market. Harvesting, sorting, and packaging mushrooms for fresh consumption is still carried out largely by hand.

There are two main reasons why the international industry is urgently seeking to (semi)automate or robotize the harvesting process. The first is costs: The share of harvest labor in the production costs of mushrooms ranges from 20% to 50%, depending on hourly labor costs, labor productivity, and other costs (such as substrate).

Second, sourcing labor for harvesting has become more difficult. For decades, workers from abroad have filled these roles in many mushroom-producing countries. The availability of local labor has been under pressure for some time, largely because international competition can make it difficult to offer competitive wages. In addition, governments are becoming more restrictive when granting temporary work permits for foreign workers engaged in mushroom harvesting.

Given the factors outlined above, there is now signification motivation – or even necessity – for growers to invest in harvest automation, and such solutions seem to be gaining real traction. This trend is apparent in many more mushroom-producing countries today than it was about 25 years ago, when concerns about high labor costs in mushroom cultivation were mainly focused on the Netherlands.

At present, we believe the extent of this shift largely depends on labor costs and the relative degree of scale enlargement in individual countries (see figure 5). The larger the scale of companies and/or labor costs per kilogram, the more likely it is that robotics will be used in mushroom harvesting.

Figure 5: Robotization will vary across countries, depending on economies of scale and labor costs

		Relative degree of scale enlargement in Agaricus production	
		Low to middle	High
Labor costs per kg	Low	Turkey, Mexico	China
	Middle	Poland, Spain, Italy	France, Ireland, Germany
	High	Netherlands, UK, US	Canada, Australia

Source: RaboResearch 2026

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Technological progress is accelerating automation

Technological advances in mechatronics, vision systems, sensor technology, and artificial intelligence (machine learning) are continuing rapidly. These advances could significantly improve both the productivity and quality of automated harvesting, and in a number of countries they could bring the cost per kilogram of harvested product below that of manual harvesting. Furthermore, for many horticultural crops, harvest automation is now high on the agenda, meaning suppliers can create crossovers of the different harvesting automation tools of various crops.

Thus, a profitable business case for harvest automation has now emerged in multiple producing countries. New picking systems appear to have reached a so-called "technology readiness level" of 7 to 8 or even 9 (out of 9), meaning they are now being applied in day-to-day operations.

Current solutions are stepping stones toward more innovative production systems

This brings a combined harvesting approach closer, in which a portion of mushrooms for the fresh market is harvested manually and another portion through automated processes. The initial challenges of adopting a new technology still need to be resolved, and during peak harvest periods, employing both methods remains practical, as automating or robotizing the "last kilogram" is not economically viable.

As long as labor shortages and labor cost issues continue to pose challenges, there will remain room for innovation within the current production system (link in Dutch) or even for much larger disruptions that could change the entire existing business operation.

In particular, the division of Agaricus cultivation into separate, dedicated spaces for mycelial colonization of casing soil and pin formation on the one hand and spaces designed for automation and robotization on the other is a development that is already underway in the industry. While this approach is understandable given the high investment costs associated with robotic systems, it can also make production operations increasingly inflexible.

Sustainability requirements, particularly around peat, could reshape production systems

Sustainability requirements are among the key developments affecting mushroom cultivation, with growing pressure from governments, NGOs, retailers, consumers, and society more broadly. For the mushroom industry, the use of peat in the production of casing soil is a key sustainability issue due to possible high carbon emissions. Once growing rooms are filled with phase III compost for Agaricus cultivation, a layer of casing soil is applied. This casing layer provides the appropriate physical and chemical conditions for pin formation. Currently, the industry typically uses casing soil composed largely of black peat. However, increasing pressure – particularly from supermarket organizations in the UK – is being exerted to replace peat use.

The sector faces growing pressure to address this challenge. One possible response is the development of a footprint analysis or life-cycle assessment for mushroom production, explicitly quantifying the contribution of peat-based casing soil and the environmental implications of transitioning to alternative casing materials. Such an analysis would provide a robust basis for dialogue among stakeholders and support consensus on the most suitable casing soil going forward.

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Scale, automation, and collaboration are needed to ensure a resilient mushroom industry

Driven by a mature market, labor challenges, and sustainability requirements, the mushroom industry is changing in Europe, North America, and Australia. The future of Agaricus mushroom cultivation is about larger companies with highly automated production systems, more vertically integrated supply chains, and more sustainable production methods. There will likely also be greater production of brown varieties.

Even as companies are getting bigger, collaboration to promote mushrooms remains crucial. With consumption stagnating in many countries, each company can try to increase its own market share, but driving overall demand growth is even more important.

In addition, it is important for the industry in Europe, North America, and Australia to act jointly to formulate an effective response to declining consumption, rising sustainability requirements, and labor challenges. Part of the solution lies in developing strategies that clearly distinguish between the pre-competitive, collective interests and the individual interests of larger companies.

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