ECONOMIC FACT SHEET

URBAN MUSHROOM FARMS

The CRETAU (Carrefour de recherche, d'expertise et de transfert en agriculture urbaine) is driven by AU/LAB (Laboratoire sur l'agriculture urbaine). AU/LAB is a research, training, innovation, and action space that serves the community, making it possible for professionals, citizens, researchers, decision-makers and entrepreneurs to collaborate on the subjects of urban agriculture and food. A not-for-profit organization, the laboratory is a national and international site for action and reflection on urban life and food. Based on a wealth of expertise and more than 10 years of experience, AU/LAB ensures that proposals, initiatives and enterprises concerned with both production and processing as well as distribution and marketing of urban agriculture emerge. The laboratory acts in view of participating in the development of an urban food system, of sustainable urban planning and of a circular economy within cities.



1401 Legendre Street West, office 305 Montreal, Quebec H4N 2R9 cretau.ca

WRITING AND RESEARCH

Adeline Cohen Coordinator, Economic Research and Accompaniment CRETAU

Camille Huot Coordinator, Engagement and Partnerships CRETAU

DIRECTION

Éric Duchemin Scientific and Training Director CRETAU

TRANSLATION

Translation by Guylaine Leclerc, certified translator, was made possible by the Government of Canada.

Funded by the Government of Canada



To quote this text

A. Cohen, E. Duchemin, A.-M. Bernier, C. Huot (2020). Economic fact sheet : urban mushroom farms AU/LAB (Laboratoire sur l'agriculture urbaine)/CRETAU (Carrefour de recherche, d'expertise et de transfert en agriculture urbaine) 36 p.

ACKNOWLEDGEMENTS

We wish to thank Dominique Lynch-Gauthier, Grégoire Bleu, Quentin Declerck and Michaël Loyer for taking the time to discuss with us to present their projects in the case studies.

We also wish to thank the enterprises that have shared their economic data to allow us to create indicators for installation costs, operation costs, and revenues for urban mushroom farms.



Anne-Marie Bernier Scientific Counsellor CRETAU

FOREWORD

This fact sheet was created to guide persons who wish to launch a farm project to produce mushrooms or decision-makers and financial institutions who wish to support this type of farm project.

Based on business case analyses as well as on data collected from numerous mushroom producers, in various contexts, this fact sheet supplies basic information on the potential costs of establishing and operating such a farm. They are guidelines as numerous factors can influence a project's final costs or the operation costs, which are very difficult to predict. The data was collected in 2019 from five operations.

This fact sheet is part of a series of economic fact sheets aiming to create an economic framework for the development and implementation of urban farms. This series is in addition to other work done by the CRETAU more specifically on the establishment of urban farming businesses, on the ecosystemic services of urban farms (economic value for the city) as well as the economic impact of commercial urban agriculture.

TABLE OF CONTENTS

URBAN MUSHROOM FARMS

CHARACTERISTICS OF URBAN MUSHROOM FARMS TYPES OF URBAN MUSHROOM FARMS Cultivation in buckets Cultivation in hanging grow bags Cultivation on mycelium blocks Grow kits KEY PARAMETERS TO LAUNCH A MUSHROOM FARM IN AN URBAN ENVIRONMENT Proximity of urban substrate elements Proximity of client base

CASE STUDIES

BLANC DE GRIS LA BOÎTE À CHAMPIGNONS LE CHAMPIGNON DE BRUXELLES LES 400 PIEDS DE CHAMPIGNON

ECONOMIC ANALYSIS

BASIS OF THE ECONOMIC RESEARCH IMPLEMENTATION OF AN URBAN MUSHROOM FARM PROJECT Revenues from the production of mushrooms Work time needed to operate a mushroom farm Estimate of the economic viability of a mushroom farm

URBAN FARMS PRODUCING MUSHROOMS

The production of mushrooms in urban environments is a new phenomenon that has become popular less than 10 years ago. Since 2013, we have identified five enterprises established in urban environments in Quebec. These enterprises are part of the larger sector of specialty mushroom farms¹, that produced in 2017 only 2% of the Canadian mushroom crop, or 2,406 tons of mushrooms². While Statistics Canada's 2016 census estimates that there are 305 mushroom farms in Canada, since the early 2000s, the proportion of specialty mushroom producers has been following an upward trend, partly because of the merge of agaricus-producing² farms.

The production of crop mushrooms in Quebec is low compared to Ontario and British Columbia which produce together 92% of the quantities produced in Canada. While the growth surface in Quebec represented 1.6 ha in 2014, it has been reduced to 0.5 ha in 2017³. There are few *Agaricus* mushroom farms in Quebec (Champag is an example), but 24 specialty mushroom farms registered with MAPAQ⁴ in 2017⁵. This suggests that the emergence of 5 urban mushroom farms since 2013 constitutes a renewal of the sector that is moving closer to its customers, while participating in the development of circular economy systems (recuperation of urban matter for the substrates and the use of production waste to improve vegetable gardens).

Although specialty mushrooms can be produced in fields, under forest cover or in a closed environment, urban mushroom farms only produce in closed environments and in containers (buckets positioned in columns, hanging grow bags, mycelium blocks or grow kits) rather than in culture beds. In closed spaces, culture rooms make it possible to control climate conditions, which has the advantage of allowing for a higher and more constant yield. It is however vital to invest in equipment to regulate temperature, humidity, carbon dioxide levels and to avoid contamination through pathogens. This much more expensive initial investment than for outside productions is matched with a longer and more complicated establishment period for the enterprise.³

¹ Specialty mushrooms include crop mushrooms other than *Agaricus* (button, brown or portobello mushrooms) such as shiitakes, oyster mushrooms or enokis. Crop mushrooms exclude mushrooms harvested in the forest.

² Statistics Canada (2019). VISTA on the Agri-food Industry and the Farm Community: Economic Profile of the Mushroom Industry in Canada, product no 21-004-X of Statistics Canada's catalogue, version updated in May 2019, Ottawa, Ontario, https://www150.statcan.gc.ca/n1/pub/21-004-x/2019001/article/00001-eng.htm (May 26, 2020)

³ Government of Quebec. (2018). Profil sectoriel de l'industrie horticole au Québec. 3rd quarter 2018, p. 39

⁴ Ministère de l'agriculture, des pêcheries et de l'alimentation (Quebec's Ministry of Agriculture, Fisheries and Food)

⁵ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec.

TYPES OF URBAN MUSHROOM FARMS

Indoor cultivation of mushrooms can be carried out on various kinds of supports: in buckets, hanging grow bags, blocks on shelves. Some mushroom farms specialize in the creation of home grow kits.

Cultivation in buckets



The buckets are generally 20-litre pails that contain the inoculated substrate and are stacked in columns to optimize space. Small sized holes allow the carpophores to come out. The buckets have the advantage of being reusable, of needing no additional equipment in the production rooms and of reducing harvesting time which is facilitated by the holes' small size. The holes also make it possible to create nice bunches.

However, bucket washing time can be long and the risk of contamination important if it is not done well enough. The buckets' opacity does not allow to see the evolution of the mycelium colonization or a possible contamination.

Cultivation in hanging grow bags



Cultivation in hanging grow bags is done in plastic bags in which the inoculated substrate is placed. Holes are made so that the carpophores can come out. Cultivation in grow bags makes it possible to see the mycelium's evolution or possible contaminants, and to choose the place and number of holes to control the size of the carpophores and the yield⁶.

Although the grow bags limit the risk of contamination because of their sterility, they must also be replaced at each cycle.

⁶ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec.

Cultivation on mycelium blocks



Mycelium blocks are substrate blocks inoculated with the mycelium and wrapped in a plastic bag. They are particularly well adapted to some kinds of mushrooms such as the shiitake. During fruiting time, the bags are opened at the top to make room for the carpophores. In some cases, special heat-resistant bags that have filters are designed so that the blocks can be sterilized in an autoclave⁷.

Also, in this case, the bags cannot be reused because of contamination risks. The production rooms also need to be equipped with shelves that will need to be cleaned between each cycle.

Grow kits



Mushroom grow kits. Photo credit: La Boîte à Champignons.

A grow kit includes a block of sterile substrate inoculated with the mycelium and wrapped in a plastic bag. The grow kits are incubated at the enterprise, but they are not sent to the fruiting room. They are then wrapped in a cardboard box and sold so that the mushrooms grow nicely on the kitchen counter.

KEY PARAMETERS TO LAUNCH A MUSHROOM FARM IN AN URBAN ENVIRONMENT

Building layout and equipment choice

Cultivation of mushrooms indoors requires important investments and the choice of a layout and equipment adapted to limit contaminations that could adversely effect production. These choices must be well thought out with expert advice or by developing less costly pilot projects.

The advantage of indoor cultivation is to be able to control the environmental parameters such as temperature, humidity, lighting, or the atmospheric level of CO₂. This layout, although expensive, makes it possible to produce year-round with a relatively good and constant yield⁸. The choice of a production space in a basement makes it possible to have a constant temperature while at the same time limiting the heating or air conditioning costs. Numerous mushroom farms can thus be found in basements.

Pasteurization is also a key element in the production process. While rural enterprises can use exterior reservoirs in which substrate is boiled or pasteurized with vapour, pasteurization in urban areas is more easily carried out in autoclaves or pasteurization systems, which also make it possible to partially automate this production step.

Finally, a ventilation system is necessary to allow for regular air change in the growing rooms. HEPA filters as well as a positive pressure ventilation at the mushroom farm's entrances and exits limit the risk that exterior contaminants enter the production space. However, the spores already inside will spread to the other rooms⁹. It is relatively frequent, even for experienced producers, to encounter production losses because of the development of pathogens in the mushroom farm. Controlling hygiene is a major challenge which requires that the employees be appropriately trained.

Mycelium's quality

Once the substrate's safety has been established, it must be inoculated with the mycelium. The mycelium's quality influences the inoculation rate, which will have a consequence on the carpophores' growth performance. Some enterprises prefer to buy the mycelium from reliable sources with genes offering a good yield. Other enterprises can decide to produce their mycelium on grain or on sawdust. The production of mycelium requires excellent expertise as well as additional layout and equipment: laminar flow hood, ventilation, HEPA filter and autoclave. It is also necessary to preserve mycelium strains in liquid nitrogen¹⁰.

⁸ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec. p.15.

⁹ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec. p.14.

¹⁰ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec, p. 4.

Once inoculated, a competition starts between the mycelium of the mushroom that we want to cultivate and the mycelium of molds. The higher the mycelium's quality, the greater the chance that it will dominate the competition and settle on the substrate. For example, a good oyster mushroom mycelium must produce 3 spawn runs over a 30-day period.

Proximity of customers and sources of urban residues

The production of mushrooms in an urban environment has the advantage of being close to the customers. Some mushrooms, like the oyster mushroom which has the shape of oysters are very perishable and can be kept in an optimal manner for 4 days. Other mushrooms such as the shiitake or the elm leech can be kept up to 2 weeks. The proximity of customers makes it possible to offer products of exceptional freshness, high quality, extremely popular among restaurant owners and individuals. Boîte à Champignons is thus located close to the Rungis, a National Interest Market in Île-de-France, and Champignons de Bruxelles is located under an organic market of the city of Brussels.

Production in an urban environment also makes it possible to recuperate urban residues such as coffee grounds, brewers' grains, or cardboard. Cultivated mushrooms are effectively all saprophytes, which means that they decompose into organic materials and feed off some substances resulting from this decomposition. Saprophyte mushrooms need organic matter with a carbon/nitrogen ratio higher than 30/1 such as straw, sawdust or wood chips. However, the use of organic matter with a higher nitrogen content (coffee grounds, grain) can stimulate the yield but it can also increase contamination risks¹¹. Blanc de gris had to interrupt the recuperation of coffee grounds for a while as it was too contaminated. Boîte à Champignons has developed a system for the recuperation of coffee grounds encouraging participants to limit contamination risks.

Development of conservation methods

While most of the studied enterprises can sell their merchandise fresh, 3 of the 5 enterprises questioned have observed the sales' seasonality. Some of them adapt and reduce their production to some periods or by closing the enterprise during two weeks during winter, according to one of the interviewed enterprises, the accuracy of production forecasts is a key factor of profitability. Other mushroom farms use processing to face the sale uncertainties, by drying or by developing marinated mushroom recipes. Marinated mushrooms are edible for a long period of time, up to a year. While processing makes it possible to add value to unsold fresh products, Boîte à Champignons observes that a mushroom farm model can easily be weakened if there are too many activities because of the extra costs generated by this strategy. Processing is an activity in its own right which requires investments if carried out by the production enterprise. It may be possible to seek partnerships to reduce investments.

¹¹ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec. p.16.

Development of product marketing

Although the surveyed urban mushroom producers are successful with customers, the sale of mushrooms is a niche market that would benefit from expanding. In Canada, the consumption of fresh mushrooms of all kinds and from all origins combined has fluctuated between 1.9 and 2.6 kg per year per person between 2009 and 2017 with a peak at 2.6 kg in 2011 and a downward trend between 2011 and 2017. In 2017, fresh mushroom consumption was evaluated at 2.1 kg per person. Processed mushroom consumption has also decreased during the same period from 0.4 to 0.2 kg per year per person¹². Although it is not possible to state that specialty mushrooms have an established place in Canadian consumer's purchase habits, they seem to be increasingly used by the high-end restaurant industry¹³.

The launch of a mushroom farm is thus premised on the development of a local client base, especially gastronome consumers, vegetarians, and vegans (mushrooms often replace meat in the recipes) or high-end restaurants¹⁴. Many of the enterprises that were included in the study have developed close ties with their clients, sometimes offering exclusive products, as is the case with Boîte à Champignons. Other enterprises, like Champignons de Bruxelles have implemented a collective structure with a microgreen producer (ECLO) to combine their offer to the region's clients.

¹² Government of Quebec. (2018). Profil sectoriel de l'industrie horticole au Québec. 3rd quarter 2018, p. 38-39

¹³ Statistics Canada (2019). VISTA on the Agri-food Industry and the Farm Community: Economic Profile of the Mushroom Industry in Canada, product no 21-004-X in Statistics Canada's catalogue, version updated in May 2019, Ottawa, Ontario, https://www150.statcan.gc.ca/n1/pub/21-004-x/2019001/article/00001-eng.htm (May 26 2020)

¹⁴ Groupe Agéco. (2017). Étude de marché pour une usine de conditionnement et de transformation de champignons forestiers.

CASE STUDIES

This section presents various cases, which, each in their own way gives information on the viability model of an urban mushroom farm and that illustrates the key parameters of a viable project.

BLANC DE GRIS



Oyster mushroom production by Blanc de gris in Montréal. Photo credit: Patrice Didier

Blanc de gris is a mushroom farm established in Montréal. During the summer of 2014, the two founders established themselves in their current premises, with a first sale of their mushrooms in October 2014. They rent the space located in a light industrial zone. Until quite recently, 75% of the space was occupied by Blanc de gris and the remainder was rented by another urban farm, but Blanc de gris has recuperated this 25% and the space will allow it to increase its production.

Production

Blanc de gris only produces oyster mushrooms in buckets.

The mushrooms' substrate is composed of microbrewers' grains and wood chips. The substrate mix is pasteurized before being inoculated with the mycelium. The only step that is automated is the mixing of the substrate and the mycelium during the pasteurization process.



Controlled condition growth area. Photo credit: Blanc de gris.

Distribution

Blanc de gris mushrooms are distributed through direct sales to approximately 40 restaurants. Occasional sales at the farm are organized and special deliveries sometimes occur in offices, but this only represents 1 to 2% of sales. Distribution is carried out internally, but delivery is subcontracted. Since the beginning of the COVID-19 crisis, the enterprise has switched towards online direct sales as well as sales in small grocery stores.

Almost all the mushrooms produced are sold fresh, but some are sometimes sent to be dehydrated when there is surplus production. The development of processed products (e.g., marinated mushrooms) is also underway.

Services

All revenues currently come from the sale of the production, but the Blanc de gris founders receive many requests for consulting services and visits. They therefore want to develop a service offer in the next years, now that the production is stabilized.

Economic model

The enterprise has four full-time employees, one part-time employee and one intern. It is a corporation.

The next research and development (R&D) step consists in finding a way to systematically add value to the substrate at the end of its life cycle. It has occasionally been sent to gardens to enrich the soil in containers or on the ground, but it is still necessary to operationalize this distribution and to document its impact on the crops.

Funding of the mushroom farm comes in large part from the equity supplied by the founders' loved ones (love money). Loans from PME Montréal, Futurpreneur Canada, the Bank of Canada and RBC bank have completed the financing package at launch.

Blanc de gris has also received an award and accompaniment through Fondation Montréal Inc.

LA BOÎTE À CHAMPIGNONS



Oyster mushroom production by La Boîte à Champignons in Saint-Nom-la-Bretèche. Photo credit: La Boîte à Champignons.

La Boîte à Champignons is a mushroom farm established in Saint-Nom-la-Bretèche in France. The enterprise is a brand of the Upcycle company which aims to feed the city with biowaste from urban environments. To accomplish this, the company develops and operates innovative agronomic systems in urban agriculture and the circular economy. Established in 2011, the enterprise started its first pilot production in shipping containers. The enterprise then moved its production to an old seven-hectare horticultural farm that is right in the middle of the future site of the urban agriculture start-up incubator in Île-de-France. This farm is a pilot site for the enterprise which allows it to test various approaches to the cultivation of mushrooms. In 2013, the French Ministry of Work extended the ESUS solidarity enterprise certification to the company.

Production

Boîte à Champignons cultivates 16 tons per year of a product for which they have exclusive rights in the region: Monte Cristo oyster mushrooms. This variety makes it possible to grow grey, yellow or pink coloured oyster mushrooms and it is characterized by its high level of dry matter. It is well known and

much appreciated by culinary chefs who value their firm texture when cooked. Furthermore, the enterprise produces between 30,000 and 50,000 oyster mushroom grow kits allowing consumers to grow their own oyster mushrooms at home.

The mushroom substrate is composed of various kinds of mixes (the enterprise owns close to 45 recipes), its content is mainly composed of coffee grounds recuperated within partner enterprises and institutions, wood chips and cardboard recuperated in the region, of straw recuperated from a neighbouring farmer and brewers' grains. To reduce contamination risks in the coffee grounds, the enterprise has set up tested logistics for the recuperation of coffee grounds in 60 partner enterprises and institutions. This program is called "Marc contre pleurote" (coffee grounds for oyster mushrooms). The partners commit to recuperating the coffee grounds in compliance with prescribed standards and in exchange, Boîte à Champignons will sell them fresh oyster mushrooms, oyster mushroom grow-athome kits or training on the cultivation of mushrooms, all at lower prices. The 5 tons of recuperated coffee grounds every week are then brought to a social reintegration organization to be sorted. It will then be mixed in with the substrate.

Distribution

At the beginning, fresh mushrooms from Boîte à Champignons were largely sold through the Rungis National Interest Market to various grocery stores or restaurants. Today, with the increase in production volumes, the enterprise mainly sells to large distributors. Very few sales are made directly at the farm. Some fresh oyster mushrooms are sold at reduced prices through the "Marc contre pleurote" program.

Almost all the produced mushrooms are sold fresh, but occasionally, during the summer when the demand for oyster mushrooms is lower, surpluses are processed into antipasti. These oyster mushrooms are processed in a local employment social enterprise.

The oyster mushroom grow kits are normally sold online or in stores through various sites and grocery stores. The targeted customers are households, the kits being easily used at home and even by children. The kits are mainly sold during the end-of-year holidays.

The enterprise has also tried to deliver fresh produce with the "Chronofresh" mail service, but it was not successful because of the high delivery costs.

Services

The company mainly produces fresh oyster mushrooms and grow kits. The enterprise also offers visits for groups at the farm, but this revenue is anecdotal. Boîte à Champignons's parent company, Upcycle offers other products and services related to urban agriculture and the circular economy.

Economic model

In terms of production, the enterprise has 12 full-time employees, 6 of whom work all year and 6 of whom work from August to December to produce grow kits. Four employees are responsible for production, there is a crop manager, a technical director, a head of R&D and 6 employees in social

reinsertion. There is also one person responsible for business development and its two cofounders who work for Boîte à Champignons, but also for Upcycle.

Around 50% of revenues come from the sale of fresh oyster mushrooms and 50% from the sale of grow kits. The profit margin from the sale of grow kits is far superior to that of fresh oyster mushrooms. However, the demand for these kits is seasonal. The cultivation of oyster mushrooms allows for a steady revenue throughout the year. Farm visits represent a symbolic annual revenue.

Circular and solidarity economy are at the heart of the enterprise's mission and operations. It maximizes the reutilization of local resources and minimizes its own waste through the distribution of its used substrate to local farmers. Various research projects are underway to optimize their production methods, increase the circularity of their production's inputs and outputs and to recuperate the CO₂ emitted by the mushrooms. The enterprise is also working with a social reintegration organization so that employees gain new skills.

Funding for the mushroom farm comes almost exclusively from private capital. A \$122,000 fund was offered by the Banque publique d'investissement (BPI) when the enterprise was launched to cover salary costs as well as R&D. The enterprise has developed a network of partners and advisers who have been able to support it on its progression through the years: agronomic, legislative, hygiene and safety, nutrition, etc.

Boîte à Champignons is considered a young innovative enterprise (jeune entreprise innovante - JEI). In France, this status gives fiscal advantages to SMEs who have R&D expenses and carry out work in the field. There is no such equivalent status in Quebec, however, some start-up help programs and preferential funding is available for young entrepreneurs¹⁵ or social and solidarity economy entrepreneurs¹⁶.

The enterprise managed to cover its fixed costs starting in 2017 and reached its breakeven point in 2019.

¹⁵ More information on the Entreprises Québec website:

https://www2.gouv.qc.ca/entreprises/portail/quebec/infosite?lang=fr&m=dossiers&x=2305769183&sm=2305769183 ¹⁶ https://www2.gouv.qc.ca/entreprises/portail/quebec/infosite?lang=fr&m=dossiers&x=1469753297&sm=1469753297

LE CHAMPIGNON DE BRUXELLES



Le Champignon de Bruxelles's mushroom production. Photo credit: Kevin Faingnaert.

Le Champignon de Bruxelles is a mushroom farm with the mission of producing healthy food and upcycling the city's organic resources. The enterprise started under the Tanneurs organic market in the city centre of Bruxelles, Belgium. Today, they are in the Cellars of Cureghem under the Abattoirs from Anderlecht, right in the city centre.

Everything started in the summer of 2014, with research on the production of only one kind of mushroom: the shiitake. After some trials, grains from the production of local beers are turning out to be an interesting input for the cultivation of these mushrooms.

At launch, a 750 m² space makes it possible for the farm to produce 2 tons of mushrooms per month. As sales go drastically down from March to August, the idea of merging with ECLO, an enterprise that grows microgreens in the neighbouring space in the cellars, buds in the mind of the partners. ECLO and Le Champignon de Bruxelles therefore join to become one cooperative in May 2018.

The partners therefore rent a space in the Cellars of Cureghem. 48% of the space is used to cultivate mushrooms and 2% of the space is used for the cultivation of microgreens. The remainder of the space is shared by the two kinds of cultures for the preparation of orders, keeping in refrigerators and storage space for raw materials.

Production

Le Champignon de Bruxelles now produces 5 types of certified organic mushrooms: shiitake, maitake, nameko, eryngii and oyster mushrooms. They are sold fresh. An anecdotal part of the production is sold as dried mushrooms and some grow kits are produced for online sales. The revenues generated through the sale of two by-products are anecdotal compared to the sale of fresh mushrooms.

The substrate used for the growth of mushrooms is a standard mix bought in Holland which is slowly being replaced by the "home-made" substrate partly composed of beer grains. Beer grains are mainly recuperated from the neighbouring brewery which is the only organic brewery in the city. Since it only brews six months a year, two other partners further away supply the grains for the remainder of the year.

Distribution

In 2019, the mushrooms were sold to 130 restaurant owners and in 100 stores (chains and independent grocery stores). The restaurants are supplied through direct sales. It is also the case for some stores, but most are supplied through two Belgian distributors specialized in organic food.

Part of the delivery is provided by employees with adapted trailer bikes (very convenient in the city centre which has a pedestrian zone that has been growing since 2015) and by car for local customers. The distributors provide delivery to customers who are outside of the Brussels-Capital region and to the retail chains.

The mushrooms are delivered to the restaurants and stores in bulk in large, standardized containers that are exchanged at each delivery, for largely zero waste sales. In some stores, they are delivered in wooden trays with a plastic lid that contains 125 g of mushrooms.



Standardized bin used for bulk distribution. Photo credit: Kevin Faingnaert.

Services

Le Champignon de Bruxelles occasionally offers vocational training to approximately ten participants at a cost of €1000 for four days. They also receive many requests for consultations each year.

Requests for visits are so numerous that they now have professional guides who offer tours in three languages (French, English, Dutch). The services offered represent approximately 10-15% of annual revenues.

Economic model

The enterprise has 10 employees, some of whom also work for the production and marketing of microgreens. It employs 15 seasonal employees, some for short periods.

R&D is still carried out on the production: the next goal is to completely replace the substrate from Holland by the "house blend". In view of closing the loop of the circular economy, the remainder of the substrate at the end of the production cycle is used to enrich the soil of 2 local farms who come and pick it up at the production site. Any excess is sent to the organic waste collection.

Le Champignon de Bruxelles cooperative was established in 2016 with microcredit loans and a crowdfunding campaign. Cooperative shares and a sum from the *Scale Up* investment fund were added to the amount to round off the financial plan. The fusion with ECLO occurred in May 2018.

The breakeven point was reached in 2018: a first small profit was reinvested in the enterprise. A loss was however made in 2019, but it had been planned in the budget as an important investment was made on equipment. This investment should make it possible to increase the production and quickly cover the deficit.

LES 400 PIEDS DE CHAMPIGNON



Cultivation of lion's mane mushroom at 400 Pieds de Champignon in Montréal. Photo credit: Michaël Loyer

Les 400 Pieds de Champignon is a mushroom farm established in Montréal. The 3 business partners - a chef, a machinist and a biologist, have supplied complementary skills to establish the business in a commercial building at the end of 2018. The sales started at the beginning of 2019 and by the end of the year, the business rented two additional spaces in the same building.

Production

In 2019, the business produced a wide variety of cultivated mushrooms on blocks: chestnut mushrooms, pholiota nameko, blue and yellow oyster mushrooms, black pearl, lion's mane, comb tooth mushroom, pioppino, enoki, shiitake and beefsteak polypore.

The substrate is made up of hardwood pellets and soy hulls, both sourced from Quebec businesses close to Montréal. The hardwood pellets are a by-product of the production of compressed wood logs of a local enterprise, while the soya hulls come directly from a farmer. The business has chosen not to use urban residues such as coffee grounds to avoid potential contaminations.

Sterilization of the substrate is done in a machine developed by one of the business partners that works like an autoclave without adding pressure. The machine can sterilize 900 kg of substrate in 12 hours. Furthermore, the business prepares its own mycelium in a laboratory set up onsite.

Distribution

Les 400 Pieds de Champignon has established its client base in about six months. Almost 40% of the production is sold through a local distributor and the remainder is distributed through direct sales to around forty restaurant owners. In 2019, the mushrooms were almost all sold to restaurants which appreciated the wide variety of mushrooms offered by the enterprise. With the COVID-19 pandemic, the enterprise was able to redirect its sales toward its distributor, food markets and supermarkets. It has also started to sell grow kits.

Services

For the moment, all its revenues come from the sale of the production and the enterprise offers no services or processed products.

Economic model

The mushroom farm has three business partners. During the first year, the business partners had jobs outside of the business, and one of the partners worked full-time while the two others worked parttime. At the end of the first year, the three partners were able to devote themselves full-time to the development of the enterprise and they started paying themselves salaries. Volunteers also help and the enterprise is planning to hire salaried staff once the investments are paid back.

The mushroom farm's funding comes from the partners' private funds as well as from bank loans. The enterprise was also able to limit the initial investments by using the partners' skills to build part of its equipment. A \$20,000 investment was necessary to buy the substrate for the first production.

The enterprise has also benefited from accompaniment services for entrepreneurs from the YES organization in Montréal. Regular follow-ups helped to develop a business plan and ask for loans.

The mushroom farm is also attempting to reduce its costs by finding partners who could pick up the used substrate blocks, either to use the blocks as soil amendment, or to continue the production of mushrooms with a smaller yield (the enterprise prefers to use the blocks for the first two spawn runs, deemed to be more productive). This collaboration with partners makes it possible to reduce waste collection costs. Finally, the partners are trying to add value to their polypropylene plastic waste that can be used in 3D printers.

ECONOMIC ANALYSIS

BASIS OF THE ECONOMIC RESEARCH

This economic study of urban mushroom farms is based on four cases¹⁷ for which we have obtained, for the most part, detailed set-up, and operation costs as well as the revenues generated by the production share of the projects. All the participating enterprises supplied data for 2019.

The collected data has allowed us to create projections to get the costs, revenues and human resources needs. In the next analysis, we will compare the projections per unit of mass of used damp substrate. Indeed, the mycelium's productivity depends more on volume (and through proximity, on the mass) of the substrate on which it can settle rather than a production surface.

	Enterprise's total surface (m ²)	Quantity of substrate used per year (tons)	Kind of marketing
Case 1	427	70	Direct sales to restaurant owners
Case 2	2,000	n.a.	Bulk sales, in markets for professionals and direct sales
Case 3	121	19	Direct sales to restaurant owners, bulk sales to a specialized distributor
Case 4	426	42	Direct sales

Table 1 Characteristics of the cases used in this fact sheet.

¹⁷ The cases studied in the economic analyses have been de-identified and are not the same as those cases presented in the case study section.

IMPLEMENTATION OF A MUSHROOM FARM PROJECT

The surface of the farms studied varies between 120 m² and 2,000 m² and reflects the enterprise's maturity level as well as its production and distribution choices. The enterprises generally start on a smaller pilot surface and expand with the increase of their sales. Furthermore, most enterprises studied have either expanded their space after a pilot phase, or they plan to do so in the coming years.

The operation surface data observed in the 4 studied cases are confirmed by the MAPAQ. Thus, the 24 specialty mushroom farms registered at MAPAQ occupied a surface varying between a few tens to many hundreds of square metres.¹⁸

The production space is often divided in many independent rooms, some of which are devoted to incubation and others to growth. Since incubation, fruiting and harvesting times vary depending on the species cultivated, the size of the incubation and fruiting spaces are therefore chosen depending on the mushrooms that the enterprise cultivates.

It should also be noted that some enterprises have decided to process their mushrooms within their facilities and devote a kitchen space to this end. Case 4 is an example of this.

	Total surface (m²)	Pasteurization and mixing surface (m ²)	Production surface (m ²)	Processing surface (m ²)	Others (m ²)
Case 1	427	28	160	56	183
Case 2	2,000	200	600	400	800
Case 3	121	2	110	2	7
Case 4	426	19	223	93	111

Table 2 Surface allocated to each production activity.

The start-up investments are very variable. Some pioneering enterprises have invested important quantities of resources and time for the development of their enterprise that needed to be designed from start to finish. The enterprises have often had to make important rental space accommodations to adapt the premises to their mushroom farm's needs. In the cases studied, these space accommodations represent investments between \$410 and \$750 per square metre.

¹⁸ CRAAQ. (2018). Fiche de synthèse : Champignons de spécialité cultivés. Collection production en émergence au Québec.

Investments in work time have also been necessary to develop urban residue supply networks. Another important cost in some cases is the purchase of pasteurization equipment; it represents \$50,000 in Case 1.

		Investment cost (Can\$)	Cost per m ² on the operation floor (\$/m ²)
Case 1	Set-up of the production site	\$250,000	\$585
Case 2	Set-up of the final production site	\$1,500,000	\$750
Case 3	Set-up of the production site	\$50,000	\$413
Case 4	Construction and set-up of the production site and a kitchen	\$300,000	\$673

Table 3. Installation costs of a mushroom farm.

REVENUES FROM THE PRODUCTION OF MUSHROOMS

Numerous factors influence the revenue from the production of mushrooms as is shown by the disparity of the Table 4 indicators. Except for the type of mushroom produced and the production volume, the elements that influence revenue are the market price, the distribution chain, and the way that the mushrooms are sold (fresh, processed or in grow kits). The mushroom farm's productivity can also vary from one mushroom farm to the next as it depends among other things on the mycelium quality, on the conservation of good sanitation and growing practises or the number of spawn runs chosen.

The annual farm income of the analyzed mushroom farms varies between \$70,000 to \$630,000 which means \$3,300 to \$4,300 per ton of damp substrate used.

In Case 1, the production has doubled each year for 3 years and should double again next year. Case 3 intends to triple its production by expanding its production space.

Cases 1, 2 and 4 mainly earn their revenue from oyster mushrooms and are therefore more comparable.

	Sales channel	Annual revenue from the sale of mushrooms ^a (Can\$)	Annual revenue per m ² on the production floor (\$/m ²)	Annual revenue per ton of production (\$/T)	Annual revenue per ton of humid substrate (\$/T)	
Case 1	Direct	\$231,000	\$1,444	\$27,176	\$3,300	
Case 2	Direct and distributor	\$629,600	\$1,049	\$19,675	n.a.	
Case 3	Direct and distributor	\$70,000	\$636	\$85,366	\$3,646	
Case 4	Direct	\$180,000	\$807	\$20,571	\$4,296	

Table 4. Revenues from the production of mushrooms

^a Fresh mushrooms, processed or in grow kits

WORK TIME NEEDED TO OPERATE A MUSHROOM FARM

The distribution of work time for a mushroom farm depends on the format in which the mushrooms are sold (fresh, processed or in grow kits) as well as the marketing methods. Furthermore, for the enterprises that develop their own substrate recipes from urban residues, R&D time can be important. Case 1 is an example of this where 25% of their time is spent on R&D.

For the enterprises that have supplied data per task, production activities (pasteurization, incubation, and fruiting) represent between 42% and 70% of the work time, marketing represented between 20% and 26% of the work time. In Case 4 that processes its mushrooms before they are sold, the processing activity represents 32% of work time.

When the number of work hours per year is compared to the quantity of substrate used, we observe that the time devoted to the mushroom farm activities can range up to a factor of two depending on the studied cases, between 111 h and 208 h per ton of damp substrate used.

Task optimization is a key factor for the success of a mushroom farm, and one can anticipate that the enterprises should continue to optimize the work time devoted to each task.

		Work hours per year					_	
	Total annual work hours (h)	Pasteurization/mix	Incubation and fruiting	Processing	Commercialization	R&D	Annual work hours per ton of damp substrate (h/T)	
Case 1	7,800	n.a.	n.a.	n.a.	n.a.	n.a.	111	
Case 2	16,940	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
Case 3	4,000	1,000	1,800	600	800	400	208	
Case 4	9,141	3,839		2,925	2,377	0	n.a.	

Table 5. Annual work time devoted to the production and marketing of mushrooms

KEY ELEMENTS FOR ECONOMIC VIABILITY

Starting with the numbers from the studied cases, we observe that an urban mushroom farm takes time to establish a profitable activity and thus needs to gather the initial capital to invest in its success.

The sales opportunities of mushrooms are extremely focused on direct sales and on distribution to high-end markets, such as restaurants or organic groceries. Urban enterprises have a definite advantage because of the freshness of their products; however, market development is essential to allow for the growth of this kind of urban farms. Urban producers will need to build on their assets, such as the capacity to supply a high-quality product, constant supply during the whole year, local sales and the direct link with its customers.

Optimization of the production space seems to also be a challenge to limit the operation costs. To this end, the mushroom farms can establish themselves in less sought-after commercial spaces such as basements and optimize the division of the space to take into account incubation and growth periods of each kind of mushroom cultivated.

The enterprises that wish to integrate into a circular economy will also need to continue to develop substrate optimal recipes from urban residues, to reduce the risk of contamination and to increase the productivity for different mushroom varieties. Furthermore, it is best that the mixing and pasteurization processes be automated to reduce labour costs. A mushroom farm must find the right balance between the investments to optimize its productivity and the market opportunities.

	On the floor production surface (m ²)	Revenue from the sale of fresh or processed mushrooms (\$/year)	HR operation costs (\$/year)ª	Other enterprise costs (\$/year)	Profit or deficit of the mushroom production (\$/year)	Other declared revenue sources (\$/year)	Project profit or deficit (\$/year)
Case 1	160	\$231,000	\$117,000	\$142,000	(\$28,000)	\$22,000	(\$6,000)
Case 2	600	\$629,600	\$254,100	n.a.	n.a.	n.a.	n.a.
Case 3	110	\$70,000	\$60,000	\$22,800	(\$12,800)	\$0	(\$12,800)
Case 4	223	\$268,700	\$137,115	\$65,500	\$66,085	\$31,300	\$97,385

Table 6. Assessment of the viability of farms producing mushrooms.

^a This estimate of human resources costs is based on an average hourly rate of \$15/h.

Case 4 Revenue from the sale of mushrooms includes the sale of mushrooms bought and processed.

ESTIMATE OF THE ECONOMIC VIABILITY OF A MUSHROOM FARM

The establishment and operation of an urban mushroom farm that is part of a circular economy is accompanied by an important investment and a need to learn quickly for the enterprise founders to operate the farm in a viable way.

Table 6 demonstrates that it is difficult for mushroom farms to reach a financial balance only with the production activity. Case 3 is a start-up and plans to reach its breakeven point by expanding, while Case 2, also expanding, will reach its breakeven point with entrepreneurship grants that are not included in the table. Case 4 shows the possibility of viability with processing.

We can also observe that many enterprises earn additional revenue outside of the mushroom production, whether it be with research funds, operation visits or consulting services. Some also look to diversification in the variety of mushrooms sold, either through the diversification of their production, or by reselling the production of other farms.

Carrefour de recherche, d'expertise et de transfert en agriculture urbaine

CRETAU



