

Economic justification for mushroom cultivation

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Abstract. The article presents the economic justification for cultivating two mushroom varieties: OUSTER type *Oyster Mushroom* and *Flammulina velutipes Velvet Shank Mushroom* over a period of three years. The process equipment list and the cost of the equipment are provided. The project implementation would require greenhouses with the area of about 300 square metres, one-off capital investments of about 7 million roubles. Detailed estimation of annual current costs is presented and the cost of production is evaluated. The expected production profitability during the first year of the project implementation is 16.5%, in the second year it is 23.2%, and it is more than 27% in the third year. The project would propose a feasible solution for both medium and small agrarian businesses. The issue of obtaining readily available (or so called *fast*) protein for complete human nutrition is of global concern. Producing animal protein requires a long time for rearing; poultry protein production takes a little less, a few months; to obtain protein from mushrooms one month is enough. Mushroom cultivation could be a solution to the global challenge of ensuring world food security, in line with the UN Sustainable Development Goal to end hunger. On the other hand, changing market needs for food, sanction embargo and the tasks of the government import substitution programme in Russia stresses the need for developing domestic production.

1 Introduction

There are several ways to achieve the UN Sustainable Development Goals: to produce affordable food, to develop energy-saving and environmentally friendly production, to end hunger in certain countries. Projects that concurrently fulfil these objectives may be of particular interest.

The current economic development settings force enterprises to run operations according to certain rules, under conditions of instability, dynamic and innovatively developing environment, increasing complexity of manufacturing relations and fierce competition. New development trends allow managing competitiveness, which becomes a complex multifactor business task requiring purposeful and coordinated work of all the operational units of an enterprise and should be completed at all management levels [1].

In today's economy, with sanctions and restrictions on the one hand, and rapid development of innovations on the other hand, any enterprise needs to focus on an urgent organisational and economic issue of maintaining a certain production stability, which

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allows successful operation in the market taking into account the sustainable development factors [2].

One of the most important development trends in agro-industrial complex (AIC) of the Russian Federation is the increase in production of import-substituting goods or products similar to foreign goods, quality improvement and technological effectiveness of products that should lead to reduction in the share of imported goods. Not all industries and businesses can sustain internal strategic growth and effective development at the same speed. Some economic spheres are able to get oriented quickly; it is easier for elements of a big business, large enterprises.

Many small agricultural enterprises face economic challenges, so a proposal for mushroom cultivation in greenhouses will help meet the local needs of regional markets for an environmentally friendly and useful product quickly and effectively; it will improve the financial performance of enterprises [3]. Producing competitive products remains one of the stable trends in agrarian business development.

It is also worthy of note that modern beef production can provide 61.8 kg of dry protein per hectare a year, modern fish farming can bring 582.6 kg, and mushroom cultivation is able to provide up to 60 tonnes. Mushrooms yield 12 tonnes per hectare per year. Artificial cultivation is favoured, as there are frequent cases of food poisoning from wild forest mushrooms due to unhealthy ecology, a large amount of exhaust gases in the atmosphere, etc. [4].

The main objective of the work is to provide economic justification for year-round mushroom cultivation in heated greenhouses.

The objectives of the study are:

- To determine one-time costs of the project.
- To calculate the current costs of entry for the production and distribution.
- To determine the project cost-effectiveness for the next three years.

Champignons have become very popular in the Russian mushroom market: there has been a surge in annual consumption since 2017. Statistics show that in 2023 the consumption of mushrooms and mushroom products increased by 2.2 times compared to 2016 [5]. Such a trend definitely ensures the relevance and significance of the research and supports studying the economic aspects of this business development.

2 Materials and methods

The present project is envisaged to consider an alternative for champignons exemplified by cultivation of two mushroom varieties: OUSTER type *Oyster Mushroom* and *Flammulina velutipes Velvet Shank Mushroom*. They will undergo primary treatment (cleaning), and it is also possible to arrange express freezing and packing. It should be noted that mushrooms are eaten not only unprocessed (fresh, pickled, brined), but also as processed products (sauces, seasonings, dehydrated uncooked food). Given this fact, the product target audience will be as follows:

- Retail buyers of fresh mushrooms (people).
- Catering enterprises (cafes, restaurants).
- Wholesale buyers (processing companies and procurement agencies).

The entrepreneurial idea is that mushrooms will be grown under environmentally friendly conditions, in closed greenhouses with a certain microclimate. They will be sold fresh, in vacuum packaging.

Oyster Mushroom is a cultivated variety of mushrooms, in terms of nutritional value it is superior to many vegetables, being between fish and meat, and by some criteria superior

to some varieties of meat. *Oyster Mushrooms* contain a full range of essential amino acids, biologically active substances that can prevent and treat a number of diseases [3, 6].

Flamulina velutipes Velvet Shank Mushroom is a very common product of Japan, Taiwan, China, it has become popular in South-East Asia. It possesses a nice taste and flavour, and is pleasant looking regardless of cooking method. Its nutritional value is high. 100 g of mushrooms contain 13.9-16.2 g of protein, 1.7-1.8 g of fat, 60.2-62.2 g of carbohydrates, more mineral nutrients than vegetables, vitamins B and C. Protein content is the highest compared to other edible mushrooms, including arginine and lysine, which has attracted medical and nutrition experts because arginine and lysine promote memory development [7].

The habit of the mushrooms is shown in Figure 1.



Fig. 1. The habit of mushroom for the designed project (*Oyster Mushroom* – to the left, *Velvet Shank Mushroom* – to the right).

Figure 2 demonstrates a greenhouse with mushroom logs. The method was first tried in Germany. The present varieties of mushrooms are quite productive, low-maintenance and do not require highly qualified staff. It remains necessary to follow the production process and collect them timely, the precision will improve storage and processing characteristics.



Fig. 2. An overview of a greenhouse with mushroom logs.

Growing *Oyster Mushrooms* has a number of advantages over other cultivated mushrooms. They are characterized by high yield, short production cycle from mycelium to fruit, bacterial and viral disease resistance, good taste, nutrition benefits, can be stored long. Moreover, *Oyster Mushroom* cultivation is waste-free. Spent substrate may serve as organic fertilizer in horticulture and gardening. Composting worm can effectively process it into complete humus in two years [8].

Main process design requirements:

- Raw materials for substrate of plant residue: straw, bark, wood waste, sunflower husks, maize cob and stalk, etc.
- Substrate preparation and application, mushroom cultivation do not incur high energy costs.

- The technology allows using available greenhouses of the production area.
- The available technology allows obtaining the actual product (fruiting bodies) in 30-35 days from the moment of inoculation.
- Advanced staff training is not required; the agronomist-technologist can undergo a short-term training.
- An opportunity to use efficiently the available labour force and real estate facilities.

The total costs of installing and arranging greenhouses are estimated at about 3.6 million roubles; obtaining a licence and certification of products will amount to another 130 thousand roubles; improving auxiliary and storage facilities will cost 920 thousand roubles. Two boiler units for heating greenhouses and the facilities will be purchases and installed; the cost is 370 thousand roubles per unit.

To ensure the production process it should be set up in accordance with the process equipment list taking into account all stages of the production cycle, labour intensity of operations, throughput capacity of machines and other characteristics [3]. The process equipment list is presented in Table 1, the cost of equipment includes VAT, delivery and installation costs; suppliers are indicated.

Table 1. The Process Equipment List.

Item Name	Supplier	Price, thousand roubles	Number of items, pcs.	Cost, thousand roubles
Packaging Machine	Japan	244.0	2	488.0
Vacuum freezing machine	Japan	196.6	2	393.2
Cool storage box for mushrooms	Feruz LLC, Russia	64.2	6	385.2
Pruning knife	Russia	7.6	8	60.8
Boiler units for heating	Russia	370.0	2	740.0
Indoor climate instruments	Feruz LLC, Russia	61.2	4	244.8
Total:				2312.0

One-off capital investments are listed in Table 2.

Table 2. One-off capital investments of the project.

Areas of capital investment	Total amount, thousand roubles
Reconstruction and arrangement of greenhouses	3570.0
Renovation of storage facilities	920.0
Certification and licencing costs	130.0
Process equipment	2312.0
Total	6932.0

Current tangible costs for mushroom cultivation are listed in Table 3 in accordance with technology requirements (humidity, temperature, etc.), planned yield during the first year is 30 tons.

In case of lack of own funds for the project implementation it is possible to take out a loan, for example, from JSC "Rosselkhozbank" in the amount of 8 million roubles for 5 years at 9.4% per annum. Interest for the loan will be included in the cost of mushrooms (in the first year it is 752 thousand roubles.), and the principal amount of the loan of 1600 thousand roubles will be paid from profit. The total production current costs are calculated for mushroom cultivation of 30 tonnes in the first year, 33 tonnes in the second year, and 36 tonnes in the third year, they are summarised in Table 4.

Table 3. Current costs for growing 30 tonnes of mushrooms.

Component Name	Measurement Unit	Number of units, pcs.	Price, roubles/unit	Amount, thousand roubles
Sunflower husk	tonnes	46	11900	547.4
Bran	tonnes	26	6160	160.2
Chaff, sawdust	tonnes	72	3470	249.8
Peat humus	tonnes	11	53100	584.1
Mycelium	tonnes	2	217 500	435.0
Complex concentrated fertilizers	kg	362	221	80.0
Cloth bags	pcs.	1200	8.8	10.6
Twine	metre	1800	1.6	2.9
Metal wire	metre	2770	83.3	230.7
Polythene film	square metre	12000	7.2	86.4
Other low value items	-	-	-	86.5
Water	tonnes	5.2	3400	17.7
Information leaflet	pcs.	60 000	3.8	228.0
Total				2719.3

Table 4. Annual current costs for the three years of the design period.

Cost items	Amount, thousand roubles
First year of project implementation per 30 tonnes of mushrooms	
Tangible costs	2719.3
Electricity costs	650.4
Utilities	578
Labour costs with taxes	2823.6
Depreciation expenses	480
Equipment maintenance and repair costs	179.2
Machine maintenance and repair costs	160.4
General administrative expenses	1467.6
Total:	8890.5
Second year of the project - 33 tonnes of mushrooms	
Tangible costs	2991.23
Electricity costs	715.44
Utilities	635.8
Labour costs with taxes	3105.96
Depreciation expenses	480
Equipment maintenance and repair costs	179.2
Machine maintenance and repair costs	160.4
General administrative expenses	981.2
Total:	9249.23
Third year of the project - 36 tonnes of mushrooms	
Tangible costs	3263.16
Electricity costs	780.48
Utilities	693.6
Labour costs with taxes	3388.32
Depreciation expenses	480
Equipment maintenance and repair costs	179.2
Machine maintenance and repair costs	160.4
General administrative expenses	830.8
Total:	9775.96

Variable costs are increased proportional to yield by 10% in the second year and by another 10% of the first year - in the third year, fixed costs remain unchanged. It is planned to pack fresh mushrooms in polythene vacuum bags, 500 grams each. The cost of one pack in the first year will be 145.4 rub./pack, in the second year - 140.1 rub./pack, in the third year - 135.8 rub./pack. The price is estimated based on the average market level of the Russian market [9].

3 Results and Discussion

The project cost effectiveness lies in achieving return on business ratio necessary for the industry development. For the sake of exposition and financial result analysis, it is appropriate to establish a target period of three years, and the cultivation will be increased by about 10% annually in the second and third years. The benefit will be derived from the specific mushroom cultivation of 30 tonnes in the first year, 33 tonnes in the second year, 36 tonnes in the third year.

The profit is accrued from a surplus product produced and necessarily sold. The profit is produced at all the stages of the production cycle, but it is realized at the stage of distribution. Profit is the primary form of net income, which ensures sustainable economic development of an organisation [10].

Table 5 presents the estimated cost-effectiveness indicators.

Table 5. Cost-effectiveness indicators.

Indicators	Values by years of the design period		
	Year I	Year II	Year III
One-off costs, thousand roubles	6932.0		
Sales receipts, thousand roubles	11022	12124.2	13226.4
Total cost, thousand roubles	8890.5	9249.2	9776.0
Profit on sales, thousand roubles	2131.5	2875.0	3450.4
Unified agricultural tax, thousand roubles	661.3	727.5	793.6
Net profit, thousand roubles	1470.2	2147.5	2656.8
Current costs profitability, %	16.5	23.2	27.2
Return on sales, %	13.3	17.7	20.1
Net profit progressive total, thousand roubles	1470.2	3617.7	6274.5
Project economic benefits progressive total, thousand roubles	83.8	2231.3	4888.1
Capital investment payback period, years	4.7		

As early as during the first year, net profit will amount to 1.4 million roubles, up to 2.1 million roubles in the second year, and up to 2.6 million roubles in the third year. Profitability ratio is also much higher, profit for the three years will be about 6.3 million roubles, payback period will be 4.7 years. The maximum costs of packaging is presented in the project. However, when shipped in bulk special containers will be used with no pre-packing, which may reduce the production cost for 3.2%, and proportionally reduce the sale price. This will not significantly affect the project results.

The proposed activities will provide a certain region with fresh mushroom products, and the agricultural enterprise will earn additional profit. The project would propose a feasible solution for both medium and small agrarian businesses.

4 Conclusion

The paper proposes specific conditions for mushroom cultivation, which do not take into account the peculiar workings of an enterprise, its size, climate, salary rate and others, so the financial result of the project may be different. The article considers a scenario of mushroom cultivation in a greenhouse. It should be noted that this method is most common in Russia, Poland, Canada, Holland, France, though a different technology can be used in terms of soil composition, mycelium structure, irrigation regimes, as well as outdoor growing.

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