Evaluation of the effectiveness of an investment project for the processing of whey

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Abstract. The role of investments in maintaining, functioning and dynamic development of the country's economy is enormous and significant. In modern market conditions of competition, the enterprise needs to constantly develop and improve. Consequently, there is a need for investment. Investments allow enterprises to get the opportunity to expand and modernize production, improve the quality of products, expand product markets, thereby increasing competitiveness. In market conditions, investment projects are necessary for everyone: consumers - investors, creditors and the entrepreneur himself, who must carefully analyze the goals set and check their feasibility. Investment decisions are leading factors in the development and increase in the market value of an organization. The article presents the calculation of the attractiveness of an investment project for the processing of whey with the subsequent use of processed products in the production of yogurt. In the course of the study, the following was established, the internal rate of return is 7.31% and shows that at such a rate of profitability, the discounted self-sufficiency of the project is achieved. Based on the calculation, the internal rate of return shows that it is advisable to attract bank loans for financing if the percentage of bank loans is not higher than 7.32%, which will make the project deliberately unprofitable.

1. Introduction
The development of the agro-industrial complex is one of the priority goals of the industry [1-6]. Milk whey is half of the milk; 50% of dry matter is transferred into it, incl. 20% protein, 95% lactose, 80% minerals and 10% milk fat. It has a high nutritional and biological value. According to theoretical calculations, this is more than 20 thousand tons of milk fat, 225 thousand tons of lactose, 30 thousand tons of protein and 35 thousand tons of minerals. World demand for milk whey will increase with an average annual growth rate of 3.1% and by the end of 2020 will amount to more than 3500 thousand tons [7,8].

In the period 2015-2018, the volume of milk whey production in Russia increased by an average of 6.9% per year. Whey powder production grew even faster - by 11.5% per year. At the end of 9 months of 2019, the Central Federal District became the leader in the production of milk whey with a share of 24.9%, which is 137 thousand tons. In Russia, the domestic production of whey powder does not fully cover the need for it due to the underdeveloped level of processing of whey, so part of the demand is replenished by imports. The share of imports in the total consumption of whey powder in 2017 amounted to 42%, or 93.3 thousand tons. Together with the increase in domestic production, imports of products in the period 2015–2018, decreased by 31.3%, or 42.6 thousand tons. According to the results of 10
months of 2019, the share of imports in the total consumption of whey powder was 22.9%, or 31.4 thousand tons [9,10].

The environmental aspect should not be disregarded: 1 ton of whey discharged into the sewer pollutes water bodies in the same way as 100 m$^3$ of household wastewater. Meanwhile, in Russia only 20% of milk whey is used. The rest is drained, and the plums cause great harm to the environment.

The main markets for dry whey consumption in the world are food (48%) and feed for agricultural animals (52%), for demineralized whey - baby food (75%) [2]. Of great importance is the development of food products using whey in the formulation [11-20].

Compared to the global consumption trend and the possibility of producing additional highly purified whey products, Russia is very far from the world leaders and needs to be improved and introduced new production technologies in order to increase the degree and depth of whey processing into the final product.

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2. Materials and methods
For the production of yoghurts with whey protein concentrates, it is necessary to introduce a technological line for processing milk whey and a line for the production of yoghurts with increased biological value using whey protein concentrates.

Below are the basic calculations and methods used to calculate the economic project for the implementation of this line in the existing production.

The following standards for financial and economic calculations are defined as the main characteristics:

- Project investments - 11 690 579 rubles
- discount rate - 14%
- income tax - 20%
- payroll - 30.2%

The project investment is 11,690,579 rubles. The sources of financing are the organization's own funds.

The calculation of the break-even point (formulas and graph) is presented in table 1.

The break-even point in monetary terms ($T_{be}$) is calculated using the formula:

$$T_{be} = B \times E_{fix} \div (B - E_{var})$$ (1)

where: $E_{fix}$ – fixed costs; $E_{var}$ – variable costs.

Substituting numerical values into formula (8), we get:

The break-even point in natural terms ($T_{nt}$) is calculated by the formula:

$$T_{nt} = E_{fix} \div (P - E_{avc})$$ (2)

where: $E_{fix}$ – fixed costs; $P$ – price for one; $E_{avc}$ – average variable costs.

Let us determine the profitability of sales ($P_s$) by net profit from the ratio between net profit and sales proceeds, i.e.:

$$P_s = (N_p/B) \times 100$$ (3)

where: $N_p$ – net profit; $B$ – revenue.

Let's calculate the economic efficiency (EE) of the company for the 1st year using the formula:

$$EE = \left( N_p \div E \right) \times 100\%$$ (4)
where: \( N_p \) – net profit; \( E \) – expenses.

The return on investment index (PI) shows the ratio of return on capital to the volume of investments in the project. PI is the relative profitability of future activities, as well as the discounted value of all financial receipts per unit of investment. If we take into account the indicator I, which is equal to the investment in the project, then the investment profitability index is calculated by the formula:

\[
PI = \frac{NPV}{I}
\]

where: NPV – net present value; I – investment in the project.

3. Results and discussions
At the initial stage, an estimate was drawn up for the purchase and installation of equipment, the data are presented in table 1.

**Table 1. Calculating the need for equipment.**

| Equipment                                           | Units | Cost, rub. | Delivery and launch costs, rub. |
|-----------------------------------------------------|-------|------------|---------------------------------|
| 1. Tank for collecting and storing whey; Vertical milk tank TMB-5000 | 1     | 918 000   | 275 400                         |
| 2. Centrifugal pumps; ONTs 1.5/20K                  | 10    | 334 380   | 100 314                         |
| 3. Separator; A1-OCM-10                             | 2     | 980 000   | 294 000                         |
| 4. Plate heat exchanger; ETNA-270                   | 1     | 293 920   | 88 176                          |
| 5. Steam injector; Valstem ADCA SI 140              | 2     | 73 500    | 22 050                          |
| 6. UV installation; A1-OUS                          | 1     | 125 000   | 37 500                          |
| 7. Vacuum evaporation plant; A2 - OBB-2             | 1     | 3 000 000 | 900 000                         |
| 8. Spray dryer; TsTR-500                            | 1     | 250 000   | 75 000                          |
| 9. Packaging machine DVDD-NOTIS-20-A                | 1     | 159 000   | 47700                           |
| **Total**                                           | 20    | 6 133 800 | 1 840 140                      |

Total total cost will leave 7,973,940 rubles.

The purchase of equipment is carried out at the expense of the owner's own funds.

Depreciation is calculated on a linear basis, taking into account the equipment service life of 5 years (table 2).

**Table 2. Calculation of depreciation of the technological line.**

| Name                                      | Equipment cost, rub. | Amount of depreciation per month, rubles | Amount of annual depreciation deductions, rubles |
|-------------------------------------------|----------------------|-----------------------------------------|-----------------------------------------------|
| 1. Whey collection and storage tank       | 918 000              | 15 300                                  | 183 600                                       |
| 2. Centrifugal pumps                      | 334 380              | 5 573                                   | 66 876                                        |
| 3. Separator                              | 980 000              | 16 333                                  | 196 000                                       |
| 4. Plate heat exchanger                    | 293 920              | 4 899                                   | 58 784                                        |
| 5. Steam injector                         | 73 500               | 1 225                                   | 14 700                                        |
| 6. UV installation                        | 125 000              | 2 083                                   | 25 000                                        |
| 7. Vacuum evaporation plant               | 3 000 000            | 50 000                                  | 600 000                                       |
| 8. Spray dryer                            | 250 000              | 4 167                                   | 50 000                                        |
| 9. Packaging machine                      | 159 000              | 2 650                                   | 31 800                                        |
| **Total**                                 | 6 133 800            | 102 230                                 | 1 226 760                                     |

Based on the formulation of yoghurt based on whey, based on the need for raw materials for the production of 100 gr. product, the calculation of costs for the production of yogurt (table 3).
Table 3. Calculation of costs for the production of yoghurt (raw materials).

| Demand for 1 ton of product, kg | Price, rub/kg | Cost, rub. |
|--------------------------------|--------------|-----------|
| Milk 3.2% fat                   | 2000         | 20        | 40 000    |
| Leaven                          | 50           | 20        | 1 000     |
| Whey protein                    | 10           | -         | -         |
| Modified corn starch, kg        | 15           | 100       | 1 500     |
| Total                           | x            | x         | 42 500    |

With the planned production of 1.9 tons of yogurt per day, the cost of raw materials will amount to 80,750 rubles per day.

The maximum production capacity of the technological line for the production of yoghurt with whey protein concentrates with a standard working time of 365 working days is 1.9 tons of yoghurt per day, the maximum number of produced cups of 200 ml of yoghurt will be 9,500 pieces per day and 288,958 pieces per month. Hence, the proposed technological line is capable of producing 57.8 tons of finished products per month. Hence, the monthly cost of raw materials will amount to 2,456,146 rubles.

Taking into account the energy consumption of 65,244 kWh per month at an average cost of 2.66 rubles/kWh, The cost of electricity will amount to 173,549 rubles. per month.

Yogurt packaging - plastic (polystyrene) cups with closed plastic lids with a capacity of 200 g, the average cost is 5.00 rubles. per piece, at maximum load, the cost of a container is 1 444 790 rubles per month.

Transport and procurement costs associated with the sale of finished products are estimated at 3.5% of the amount of material costs.

This project involves the introduction of a technological line for the production of yoghurt with whey protein concentrates at an operating enterprise.

The project provides for the filling of staff units:

- Shift foreman - 1 person;
- Apparatchik - 1 person;
- Packing operator - 1 person;
- Laboratory assistant - 1 person;
- Technologist - 1 person;
- Mechanic - 1 person.

The staff works 2 through 2 (2 work, 2 at home), 2 teams each. The enterprise works every day - 365 days (seven days a week).

Table 4 shows the calculation of the payroll for the project staff, taking into account insurance premiums.

Table 4. Calculation of the wage fund.

| Name of employee categories | Number of people | Salary of one employee, rub. | Salary amount, rub. | Accruals to funds (30.2%), rubles | Total, rub. | Total for a year, rubles |
|-----------------------------|------------------|------------------------------|---------------------|-----------------------------------|-------------|-------------------------|
| 1. Shift foreman            | 2                | 30 000                       | 60 000              | 18 120                            | 78 120      | 93 7440                 |
| 2. Apparatchik              | 2                | 25 000                       | 50 000              | 15 100                            | 65 100      | 78 1200                 |
| 3. Packing operator         | 2                | 26 000                       | 52 000              | 15 704                            | 67 704      | 81 2448                 |
| 4. Laboratory assistant     | 2                | 24 000                       | 48 000              | 14 496                            | 62 496      | 74 9952                 |
| 5. Technologist             | 2                | 30 000                       | 60 000              | 18 120                            | 78 120      | 93 7440                 |
| 6. Mechanic                 | 2                | 27 000                       | 54 000              | 16 308                            | 70 308      | 84 3696                 |
| Total                       | x                | x                            | 32 4000             | 97 848                            | 421 848     | 506 2176                |
The total monthly payroll is 421,848 rubles, the annual payroll is 5,062,176 rubles. For the next 2 years of the project’s implementation, an employee’s salary increase is not planned.

Based on the assessment of the costs associated with the production and sale of products, taking into account the maximum volumes of production and sales, the total cost of production was calculated (table 5).

**Table 5. Calculation of the total cost of yoghurt (monthly costs at maximum load).**

| Costs (for 288,958 glasses of 200 ml yoghurt) | Amount, rub. |
|---------------------------------------------|-------------|
| Raw materials                               | 2,456,146   |
| Power supply                                | 173,549     |
| Container and packing material              | 1,444,790   |
| Salary with deductions                      | 421,848     |
| Depreciation of fixed assets                | 102,230     |
| Fare                                        | 85,965      |
| Total                                       | 4,684,528   |

As can be seen from the calculations presented in table 5, with the maximum equipment load, 288,958 glasses of yogurt (200 ml) will be produced, the total monthly cost for the month is 4,684,528 rubles, with the maximum equipment load.

The calculation of the cost of 1 glass of yogurt (calculation) is presented in table 6.

**Table 6. Calculation of the cost of 1 cup of yogurt (calculation).**

| Product type | Yogurt (200 ml) |
|--------------|-----------------|
| Production volume, pcs. | 288,958 |
| Raw material consumption, rub. | 8.5 |
| General production costs, rub. | 10.91 |
| Production cost of 1 piece, rub. | 19.41 |
| General operating expenses, rub. | 5.3 |
| Full cost price, rub. | 24.71 |
| Extra charge, rub. | 5.29 |
| Price, rub. | 30 |

In competition policy, the method of price competition was used. The average price for yoghurts is 20 - 36 rubles and continues to increase. Consequently, the price of yogurt will be higher than the minimum and will be 30 rubles.

Taking into account the fact that in the first year of operation of equipment for the production of yoghurts with whey protein concentrates, production will reach a production capacity of 80%, in the second year - up to 95%, it is planned to reach 100% production capacity within 3 years of production.

Taking into account the production capacity, the process of establishing the production process, market conditions and seasonality of sales, a production program for the production and sale of yoghurt for the first year of production has been developed.

The calculation of proceeds from the sale of yoghurt (200 ml) for 3 years is presented in table 7.

**Table 7. Calculation of proceeds from the sale of yoghurt (200 ml).**

| Index                        | 2021      | 2022      | 2023      |
|------------------------------|-----------|-----------|-----------|
| Production volume in kind, tons | 554,9     | 659       | 694       |
| Sales volume in kind, pcs.   | 2,774,500 | 3,295,000 | 3,468,000 |
| Selling price per unit of production, rub. | 30         | 31        | 32        |
| Proceeds from product sales, rubles | 83,235,000 | 102,145,000 | 110,976,000 |

It can be seen from table 7, when reaching the maximum production capacity, the volume of production and sales of yoghurt increases.
The calculation of net profit for the first year of production operation is presented in table 8.

| Index                          | 2021       | 2022       | 2023       |
|--------------------------------|------------|------------|------------|
| Income                         | 83,235,000 | 102,145,000| 110,976,000|
| Costs:                         |            |            |            |
| Raw materials                  | 23,582,400 | 27,999,000 | 29,478,000 |
| Power supply                   | 2,082,588  | 2,082,588  | 2,082,588  |
| Container and packing material | 13,872,500 | 16,475,000 | 17,340,000 |
| Fare                           | 825,384    | 979,965    | 1,031,730  |
| Salary with deductions         | 5,062,176  | 5,062,176  | 5,062,176  |
| Sinking fund                   | 1,226,760  | 1,226,760  | 1,226,760  |
| Total expenses                 | 46,651,808 | 53,825,489 | 56,221,254 |
| Taxable income                 | 36,583,192 | 48,319,511 | 54,754,746 |
| Income tax (20%)               | 7,136,638  | 9,663,902  | 10,950,949 |
| Net profit                     | 29,266,554 | 38,655,609 | 43,803,797 |

Receipt of proceeds for the first year of activity in the amount of 83,235,000 rubles, will allow you to cover current costs without receiving a loss. Taking into account operating costs and taxes paid, yoghurt production brings a stable income, while there is a positive trend in the growth of net profit.

The calculation of investment costs is presented in table 9.

| №    | Cost item                      | Amount, rub. |
|------|--------------------------------|--------------|
| 1    | Equipment                      | 6,133,800    |
| 2    | Raw materials                  | 1,965,200    |
| 3    | Container and packing material | 1,156,042    |
| 4    | Fare                           | 1,840,140    |
| 5    | Depreciation deductions        |              |
| 6    | Electricity                    | 173,549      |
| 7    | Salary with deductions         | 421,848      |
|      | Total                          | 11,690,579   |

Taking into account the sale of 2,774,500 pcs. glasses of yoghurt fixed costs will be 1,226,760.00 rubles, variable costs - 45,425,048.00 rubles, the average price per unit of goods - 30 rubles, average variable costs - 16.37 rubles per unit. Hence, in order to carry out a break-even activity, it is necessary to produce 90,020 glasses of yoghurt per year and ensure revenue of 2,700,595.03 rubles, which is 3.24% of the planned revenue (table 10).

| №          | Initial data                  | Calculated values |
|------------|------------------------------|-------------------|
| Revenue (RUB) | 832,350,000,00              | 30,00             |
| Implementation (batch) | 2,774,500,00 | Average variable costs (RUB) | 16,37 |
| Fixed costs (RUB) | 1,226,760,00  | Break-even point (RUB) | 2,700,595,03 |
| Variable costs (RUB) | 454,250,048,00 | Break-even point (pcs.) | 90,020 |

Substituting the numerical values of the indicators into the formula (10), we get:

\[ P_s = (29,266,554/83,235,000)*100\% = 35,16\% \]

The level of profitability of sales for the 1st year according to table 28 will be 35.16%.

Substituting numerical values into formula (11), we get:
EE = (29 266 554/46 651 808)*100% = 62.73%
Payback period of the project: 11 690 579/29 266 554 = 0.4 years or 5 months.
Table 11 presents an assessment of the economic efficiency of the project.

| Indicator                              | Year 0 | 1   | 2   | 3   |
|----------------------------------------|--------|-----|-----|-----|
| Revenue, rub.                          | 83 235 000 | 102 145 000 | 110 976 000 | 110 976 000 |
| Full cost price, rub.                  | 46 651 808 | 53 825 489  | 56 221 254   | 56 221 254   |
| Gross profit, RUB                      | 36 583 192 | 48 319 511  | 54 754 746   | 54 754 746   |
| Net profit, RUB                        | 29 266 554 | 38 655 609  | 43 803 797   | 43 803 797   |
| Payback period, months                 | 5      | 35.16| 37.84| 39.47|
| Return on sales, %                     |        | 62.73| 71.81| 77.91|
| Economic efficiency, %                 |        | 62.73| 71.81| 77.91|
| Project investments, rub.              | -11 690 579 | 214 832 541 | 214 832 541 |
| Net present value (NPV), rub.          |        | 214 832 541 | 214 832 541 |
| Internal rate of return (IRR), %      |        | 7.31 |      |      |
| Investment return index (IPI), %       |        | 18.37|      |      |

4. Conclusion

Based on the calculations presented in table 28, it can be seen that net present value (NPV), which is equal to the difference between the amount of cash receipts (investments) available at a given time and the amount of required cash payments to repay loan obligations, investments or to finance the current needs of the project, the difference is calculated based on a fixed discount rate. The weighted average interest rate of Sberbank on credit and deposit operations in rubles as of 01.01.2020 is chosen as the risk-free interest rate - 14.0% per annum. The net present value of the project is greater than 0, which indicates that the project will bring profit to investors.

Internal rate of return (profitability) (IRR) is calculated depending on the value of NPV. IRR is the maximum possible investment value as well as the level of eligible project costs. So for this project, the internal rate of return is 7.31% and shows that at such a rate of profitability, the discounted self-sufficiency of the project is achieved. Based on the calculation, the internal rate of return shows that it is advisable to attract bank loans for financing if the percentage of bank loans is not higher than 7.32%, which will make the project deliberately unprofitable.

The investment return index for this project is more than one, therefore, this project is profitable, it should be accepted for implementation.

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