Assessment of efficiency of canned vegetables production

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Abstract. This research is to assess the efficiency of canned vegetables production. In order to plan the production activities a wide range of parameters is analyzed, for instance the costs production, profit, market, finance, taxation system and political situation. However, the assessment of these parameters is necessary with reference to a specific aims and tasks. The specific time or period, which those parameters are assessed within, is also important. Here the process of launching into production of 2 kinds of canned vegetables on a new production line is considered. The assessment of production efficiency is given on the base of Net Present Value (NPV), internal rate of return (IRR), productivity index. The obtained data proves the expediency of the project; its implementation will increase the economic stability of the enterprise.

1. Introduction
Canned fruits and vegetables occupy quite significant share of the food market and are in constant demand. The main reason is the food tastes and food behavior of Russian consumers that has been formed over many years [1-6].

The peculiar feature of canned products is their long shelf life and a wide assortment. The canned fruits and vegetables are traditionally used for various dishes; they are good both for everyday use and for festive food.

In particular, the production of canned fruits and vegetables feature some peculiarities: the high cost of equipment and high operating costs are also added. Business planning can become an efficient method for planning and modeling those sophisticated terms.

Planning the financial and economic activities of the enterprise consists of developing a plan aimed at achieving clearly formulated tasks together with the timing of these aims implementation [7-14].

Nowadays a range of authors distinguish two forms of planning the enterprise’s activities: planning the enterprise’s activities in the market; planning of the internal activity of the enterprise.

For planning a row of parameters are analyzed, such as production costs, profit, market, finance, taxation system and political situation. However, these parameters must be assessed with reference to
a specific aim and tasks, also the time or period within which the parameters are assessed are also important parameters. In view of the above herewith we set the task to assess the efficiency of production of canned vegetables via a business plan.

2. Materials and methods
The article calculates the technological parameters of canned vegetables produced according to the recipe presented below in Table 1.

**Table 1.** The recipe for canned vegetable snacks “Squash spread with fresh herbs” and “Eggplant spread with fresh herbs”.

| Cooked vegetables and food ingredients | Squash spread with fresh herbs | Eggplant spread with fresh herbs |
|----------------------------------------|-------------------------------|-------------------------------|
| Fried squash or scallop squash         | 77.33                         | -                             |
| Fried eggplants                        | -                             | 70.0                          |
| Roasted carrot                         | 4.6                           | 4.6                           |
| Roasted white roots                    | 1.3                           | 1.3                           |
| Fried onion                            | 3.2                           | 3.2                           |
| Fresh greens                           | 0.3                           | 0.3                           |
| Granulated sugar                       | 0.75                          | 0.75                          |
| Salt                                   | 1.5                           | 1.5                           |
| Ground black pepper                    | 0.05                          | 0.05                          |
| Ground allspice                        | 0.05                          | 0.05                          |
| Tomato puree, 12%                      | -                             | 18.25                         |
| Tomato paste, 30%                      | 7.32                          | -                             |
| Heat-treated vegetable oil             | 3.6                           | -                             |

Below are presented the initial data used in the calculations.

A technological line is used for production. The cost of the line is 8,349,380 rubles, including delivery and installation by outsourced enterprise. Its service life, according to the technical documentation, is 8 years (monthly depreciation rate is 1.19%, so monthly depreciation amount 99,357.62 rubles).

Electric power is kW 60.

The technological line is serviced by 4 employees: 2 workers, 1 technologist and 1 mechanic (per 1 shift).

Power consumption: 60 kWh, the cost of electric power is 3.09 rubles per kWh (according to the rate for this territorial zone), so the cost will be 2 224.8 rubles per day.

The raw material cost of squash spread with fresh herbs is 24,068 rubles per ton.

The raw material cost of eggplant spread with fresh herbs is 26,578 rubles per ton.

The monthly payroll fund is 485,386 rubles, the annual payroll fund is 5,824,627 rubles.

No salaries increases are planned for the next 2 years of the project running.

The following formulas are also used for efficiency calculations:

Revenue:

\[ P = Pr \times V \]

Pr – Release price of one piece of product
V – volume of sold products.

Payback period (simple):
where $PP$ – is the payback period, years;
$I_0$ – Initial investments;
$CF_t$ – net cash receipts from implementation of investment project per year $t$.

Net present value (NPV):

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1 + E)^t} - I_0$$

where $E$ - is the desired rate of return (discount rate);
$I_0$ - initial investment (investment costs),
$CF_t$ is the net cash flow at the end of period $t$.

Productivity index

$$PI = \left[ \sum_{t=1}^{n} \frac{CF_t}{(1 + E)^t} \right] / I_0$$

where $E$ is the desired rate of return (discount rate);
$I_0$ - initial investment of funds (investment costs),
$CF_t$ is the net cash flow at the end of period $t$.

3. Results and discussion

At the initial stage it is necessary to determine the semi-variable costs. The semi-fixed costs and overhead costs are distributed in proportion to consumption of the basic raw materials. Transportation and procurement costs related to the sale of finished products are estimated at 0.3% of raw materials cost. Based on assessment of the costs associated with the production and sale of products, taking into account the maximum volumes of production and sales, the amount of monthly fixed and variable costs was calculated.

Taking into account the data provided above the total costs of production amounts to 1.290.385 rubles per month.

In compliance with competition policy the marginal cost calculation method is used. Variable costs per unit are multiplied by a percentage sufficient to cover the costs of the enterprise and to make a profit.

The calculation is presented below in table 2.

**Table 2.** Calculation of the cost of the finished product (direct-costing method).

| Parameters                        | Squash spread with fresh herbs | Eggplant spread with fresh herbs | Total     |
|----------------------------------|--------------------------------|---------------------------------|-----------|
| Monthly production volume, tons  | 5.400                          | 3.960                           | 9.360     |
| Production prime cost of output, rub. | 180 302.355               | 142 160.931                     | 322 463.286 |
| General production costs, rub.    | 729.050                        | 561.336                         | 1 290.385 |
| Production prime cost of output, rub. | 181 031.405               | 142 722.267                     | 323 753.671 |
| Advertising costs, rub.           | 779.436                        | 564.419                         | 1 343.855 |
| Full cost of 1 tube, rub.         | 33.669                         | 36.184                          | 69.852    |
| Full cost price of 1 can, rub.    | 16.16                          | 17.37                           | x         |
| Margin of the enterprise, rub.    | 14.09                          | 15.01                           | x         |
VAT 20%, rub.
Margin of the enterprise (VAT incl.), rub.
Wholesale price of the enterprise, rub.

|                | 6.05 | 6.48 | x  |
|----------------|------|------|----|
| VAT 20%, rub.  |      |      |    |
| Margin of the enterprise (VAT incl.), rub. | 20.14 | 21.48 | x |
| Wholesale price of the enterprise, rub. | 36.30 | 38.85 | x |

According to the production schedule these vegetables are canned only 4 months a year (July - October), in the rest of the period only limited quantities of the vegetables are supplied to the enterprise. Taking into account the production capacity, time for adjustment and fine tuning of the production process, market conditions and seasonality of sales, a production schedule has been developed. The schedule for the production and sale of canned vegetables in 3 years looks as follows:

Squash spread with fresh herbs:
The first year of the project – 24 667.500 thousand pcs
The second year of the project – 30 420.000 thousand pcs
The third year of the project – 31 980.000 thousand pcs

Eggplant spread with fresh herbs:
The first year of the project – 24 667.500 thousand pcs
The second year of the project – 30 420.000 thousand pcs
The third year of the project – 31 980.000 thousand pcs

It is obvious that when reaching the maximum production capacity, the volume of production and sales of canned vegetables increases. So, in the second year of operation due to the increase in production volumes it is planned to increase this value in comparison with the first year - for squash spread by 23.32% and by 29.64% in the third year of operation, for eggplant spread by 20.82% and 27.02% respectively.

Taking into account the developed marketing strategy and the need for equipment and raw materials, an estimate of the one-time costs was drawn up. When calculating one-time costs, it was taken into account that at the time of new technology introduction there were stocks of squash and spices in warehouses. So the costs were provided for purchase of eggplants and missing ingredients according to the developed technological recipe.

One-time costs amount to 14.000.000 rubles. The sources of financing - are the own funds of the enterprise.

Below calculation of proceeds obtained from sale of canned vegetables, taking into account the release price, is presented below:

Squash spread with fresh herbs:

\[
P_{1\text{year}} = 24667.500 \times 36.3 = 895430.250
\]

\[
P_{2\text{year}} = 30420.000 \times 38.2 = 1162044.000
\]

\[
P_{3\text{year}} = 31980.000 \times 40.1 = 1282398.000
\]

Eggplant spread with fresh herbs:

\[
P_{1\text{year}} = 18460.640 \times 38.85 = 717195.864
\]

\[
P_{2\text{year}} = 22308.000 \times 40.2 = 896781.600
\]

\[
P_{3\text{year}} = 23452.000 \times 42.4 = 994364.800
\]

As it is presented above, when reaching the maximum production capacity, the volume of production and sales of canned vegetable snacks increases. So, in the second year of enterprise’s operation, due to the increase in production volumes and minor increase in wholesale prices, the company plans to increase its sales in comparison with the first year by 27.67% and by 41.18% in the third year of operation.

Calculation of financial results obtained from the production and sale of products is presented
below in table 3.

For the first year of operation proceeds were obtained in amount of 1 612 626.114 rubles. This sum is sufficient to cover current costs without incurring a loss. Taking into account the current costs and taxes paid, the production of squash spread and eggplants spread with fresh herbs brings a stable income, while a positive trend of net profit growth is observed.

Based on forecast calculations, the rate of proceeds increase for the second and third year of operation of production will amount to 27.67% and 41.18%, respectively. The rate of proceeds growth exceeds the rate of costs growth, which will be 22.03% and 24.08% respectively. The total increase of profit for the third year in comparison with the first year of new product introduction will amount to 28.45%, which proves the profitability of the project.

Table 3. Financial results from production and sales of products.

| Parameter                        | Total for the year, rubles | 1st year, rubles | 2nd year, rubles | 3rd year, rubles |
|----------------------------------|---------------------------|-----------------|-----------------|-----------------|
| Revenue (income)                 | 1 612 626.114            | 2 058 825.600   | 2 276 762.800   |
| Costs:                           |                           |                 |                 |                 |
| VAT                              | 322.25 222.8              | 411 765.120     | 455 352.560     |
| Cost of sales:                   |                           |                 |                 |                 |
| - raw materials                  | 520 517.231               | 636 018.780     | 636 024.280     |
| - electric power supply          | 222.480                   | 300.269         | 325 786         |
| - containers and packing material| 252 299.619               | 308 458.800     | 324 277.200     |
| - salary with necessary deductions| 5 824.627               | 5 824.627      | 5 824.627       |
| - amortization fund              | 1 192.291                 | 1 192.291      | 1 192.291       |
| Selling expenses:                |                           |                 |                 |                 |
| - fare                           | 1 561.552                 | 1 908.056       | 1 908.073       |
| - advertising                    | 1 343.855                 | 1 715.688       | 1 897.302       |
| Total expenses                   | 1 051 732.675             | 1 298 556.112   | 1 350 910.026   |
| Taxable profit                   | 560 893.439               | 760 269.488     | 925 852.774     |
| Income tax (20%)                 | 112 178.688               | 152 053.898     | 185 170.555     |
| Net profit                       | 448 714.751               | 608 215.590     | 740 682.219     |

At the final stage the efficiency of canned vegetables production was assessed, the data are presented below in table 4.

Table 4. Parameters of the economic efficiency of canned vegetables production.

| Parameter                      | 0       | 1       | 2       | 3       |
|--------------------------------|---------|---------|---------|---------|
| Revenue, rub.                  | -       | 1 343 855.095 | 1 715 688.000 | 1 897 302.333 |
| Variable costs, rub.           | -       | 780 425.509  | 952 510.533  | 968 359.966  |
| Fixed costs, rub.              | -       | 2 536.147   | 2 907.979   | 3 089.594   |
| Total costs, rub.              | -       | 782 961.656  | 955 418.512  | 971 449.560  |
| Marginal income, RUB           | -       | 563 429.586  | 763 177.467  | 928 942.367  |
| Net income, RUB                | -       | 448 714.751  | 608 215.590  | 740 682.219  |
| Simple payback period (PP), months | - 0.37 | -       | -       | -       |
| Profitability, %               | -       | 33.39     | 35.45     | 39.04     |
| Project currency, rub.         | -14000.000 | -       | -       | -       |
| Net present value (NPV), rubles.| -       | 1 178 829.689 | 1 320 221.916 | 1 280 679.075 |
4. Conclusion

The assessment of the economic efficiency of canned vegetables production showed that, taking into account the sale of 11,840 th. cans of squash spread and 8,862 th. cans of eggplant spread, the fixed costs amount to 2,536,147 rubles (advertising costs, deductions to the equipment depreciation fund), variable costs amount to 780,425,509 rubles (costs directly related to the production of the goods), the average price per piece is 37.58 rubles, average variable costs value is 18.10 rubles for a conditional can of vegetable spread. So, in order to run lossless operation, it is necessary to produce 130,196 cans of vegetable spread per year and ensure proceeds in amount of 6,049,050 rubles, which is 0.45% of the planned revenue.

Based on the above presented calculations, it is obvious that the 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 cash payments necessary 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 for loans and deposit operations in rubles as of 01.01.2020 is chosen as risk-free interest rate, that is 14.0% per annum. The net present value of the project is greater than 0, which proves that the project will bring profit to its investors.

Internal rate of return (IRR) is calculated depending on value of NPV. IRR is the maximum possible investment value as well as the level of allowable costs of the project. So for this project the internal rate of return is equal to 7.39%. At this rate of profitability the project achieves its discounted self-sufficiency. Based on the calculation, the internal rate of return shows that it is advisable to invest bank loans for its financing if the interest of the bank loan is not higher than 7.4%. Higher interest will make the project deliberately unprofitable.

The productivity index (PI) index shows the ratio of return on capital to volume of investments in the project. PI is the relative profitability of future operations as well as the discounted value of all financial proceeds per unit of investment.

If the parameter I (which is equal to the investments in the project) is taken into consideration, then the investment profitability index is calculated according to the following formula: PI = NPV/I. The productivity index for this project is more than 1, therefore this project is profitable, thus this project is feasible for its implementation.

### References

[1] Rebezov M, Naumova N, Lukin A, Alkhamanova G and Khayrullin M 2011 Food behavior of consumers (for example, Chelyabinsk) *Voprosy Pitania* 80(6) 23-6

[2] Suychinnov A et al. 2019 Vitamins and their role in human body *International Journal of Pharmaceutical Research* 11(3) 1246-8 doi: 10.31838/ijpr/2019.11.03.018

[3] Kulushhtayeva B et al. 2019 Gluten-free diet: positive and negative effect on human health *Indian Journal of Public Health Research & Development* 10(7) 906-9

[4] Gavrilova N et al. 2020 Specialized sports nutrition foods: review *International Journal of Pharmaceutical Research* 12(2) 998-1003

[5] Zhumanova G et al. 2018 Prospects of using Poultry by-Products in the technology of chopped semi-finished products *International Journal of Engineering and Technology (UAE)* 7(3.34 Special Issue 34) 495-8

[6] Varivoda A et al. 2018 Development of dietary food with the use of soy protein *Research Journal of Pharmaceutical, Biological and Chemical Sciences (RJPBCS)* 9(4) 1005-13 WOS:000438848100137

[7] Goldstein G 2019 *Strategic management: lecture notes* (Taganrog) p 93

[8] Guskova I 2018 *Strategic Management: Study Guide* (Moscow) p 190
[9] Igoshin N 2019 Investments. Organization of management and financing: textbook *Moscow Finance* 186
[10] Shim Jae K et al. 2015 Accounting Handbook *Barron's Accounting Handbook* 356
[11] Becker G 2019 Accounting Principles: The Ultimate Beginner’s *Guide to Accounting Paperback* 216
[12] Charles Wheelan Naked Economics Undressing the Dismal Science (Fully Revised and Updated) 2020
[13] Kofman Fred 2015 Conscious Business *Moscow: Lights* 423
[14] Brigham Eugene F and Ehrhardt Michael C 2017 *Financial Management: Theory and Practice* 24-8