New approaches to pricing in the agro-industrial complex

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Abstract. The article deals with the issues of the state of pricing in the agro-industrial complex and the need to change approaches to pricing for agricultural products and determining the profitability of sales. The main factors influencing pricing are considered. The aim of the study is to develop a methodology for determining the increase in profitability of sales based on the dynamics of the influence of indicators of price changes and the volume of sales of the previous year, as well as the development of an equation for determining the optimal amount of products based on the price calculation. The presented approaches to pricing allow you to flexibly respond to changes in the market conditions of agricultural products. The demand for products depends on a well-formed price, which ultimately affects effective agribusiness. It is the efficient agribusiness that is the locomotive for the development of rural areas, the condition for the consolidation of young people in the countryside. This technique can be used in forecasting and planning the volume of sales of agricultural products both at the level of agricultural producers and at the regional level within the framework of food security in any country in the world.

1. Introduction

The past year was not quite easy for agriculture, as the entire economy of the industry functioned in the conditions of COVID. At the same time, this did not prevent a good harvest for grain crops, the gross grain harvest amounted to more than 133,000,000 tons, which is only 2,000,000 tons lower than the record in 2017. It should be noted that since 1970, Russia has consistently exceeded the 100,000,000 marks for grain production. If at the beginning of the period grain production was in the range of 101,000,000-108,000,000 tons, then since 2016 it exceeds 120,000,000 tons [1]. According to the Ministry of Agriculture, the threshold values of the Food Security Doctrine are exceeded for grain, vegetable oil, fish products, for meat and meat products, sugar they are at the level of 100 %, and slightly lower for potatoes.

Over the past 10 years, the agri-food sector has been one of the few contributing to the country’s real gross domestic product (GDP) growth. The role of the agricultural sector of the economy in the socio-economic development of the country is difficult to overestimate. It is constantly increasing, since all sectors of the Russian economy interact directly or indirectly with the agro-industrial complex [2]. The special position of the agricultural sector in the national economy is due to the fact that there are about 80 industries in the economy where agricultural products are used as vital resources [3]. Despite the huge importance of the agricultural sector in the country's economy, the introduction of digital transformation in it lags far behind other industries. It should be noted that in
agricultural production, most traditional, outdated and, as a rule, expensive methods of farming are used, which does not quite successfully affect its final results [4].

Economic transformations in Russia over the past decades have led to serious structural changes in the economy of the regions, as a result of which not only interregional differences have increased, but also there has been a differentiation of the socio-economic development of municipalities at the level of subjects [5]. For example, Nizhny Novgorod region takes the 20th place in Russia in terms of export, the total export volume is only 13% of the volume of products shipped by processing enterprises. As in Russia as a whole, the region’s economy depends on the import of equipment [6]. Ensuring import substitution and self-sufficiency in agricultural products can be achieved in modern conditions only through the development of high-tech industries and the introduction of advanced innovative technologies [7]. At the same time, it is necessary to study and use in your practice the experience of foresight technologies for the sustainable development of rural areas used in foreign countries, which brings significant economic benefits. Naturally, when conducting foresight research, it is necessary to take into account the specifics and capabilities of the domestic agricultural complex, its agricultural potential, as well as the specific conditions of the local level [8]. The experience of Latin America in the Asian region is interesting, where agro-industrial clusters are created within the framework of the production of certain types of products allowing, due to the integration of production facilities, to form appropriate prices for manufactured products. According to Karkh D, Gayanov V and Aimel F integration processes in trade stimulate the development of the food industry. “Clustering” of food sphere as one of the forms of integration will make it possible to most effectively solve urgent problems of the industry [9]. There are many good examples of agribusiness clusters in Latin America. The Asian region is now starting to integrate agri-food clusters into the mainstream of changes in agriculture, agriculture and food processing [10].

Considering the variety of factors necessary to increase the competitiveness of agricultural production reflected in the works of scientists-economists, we note that one of the most important components of increasing demand, in addition to the above measures, is the correct formation of prices for agricultural products. The financial stability of the agricultural business depends on pricing and understanding the limits of price reduction for each type of product. It is efficient agricultural activity that is one of the conditions for securing youth in the countryside, replenishing the municipal budget and developing rural areas.

The aim of the article is to show new approaches to the pricing of agricultural products, as well as to determine the profitability of sales, taking into account the dynamics of changes in prices and the volume of products sold in the previous period.

2. Methodology

The effective organizing of production in modern conditions depends on many factors. One of the most important is the practice of the pricing. Price as an economic category characterizes the nature of the market and the economic system as a whole, determines the structure of production and has a decisive impact on the efficiency of agribusiness, as well as on the level of well-being of the population. Currently, the main way to determine the profitability of sales is to calculate this indicator based on the reporting indicators at the end of the year, without taking into account the dynamics of the impact of price changes on the volume of products sold. At the same time, when forming the price of food, the solvency of buyers is not taken into account based on the average salary in the municipality (the place of sale of products). When evaluating the effectiveness of agribusiness, we propose to determine the increase in profitability of sales based on the dynamics of changes in prices and the volume of products sold using correlation and regression analysis methods to compile an equation of the impact of price changes on the volume of products sold. The article also used mathematical methods for calculating certain integrals to determine the increase in profitability of sales and composing the equation of the intersection of straight lines to determine the optimal quantity of products based on price changes.
Particular importance is attached to the pricing of agricultural products in the economy, since it largely determines the sustainable development of rural areas and the food security of countries in basic food products.

At the same time, reducing the price while maintaining the competitiveness of agricultural organizations is impossible without a large-scale modernization of production, as well as the introduction of advanced technologies and modern information support [11].

The largest market for agricultural raw materials is the grain market. The imperfection of market pricing mechanisms does not allow us to form objective prices for grain. Currently, the price of Russian wheat on the international market is lower than that of American wheat. At the same time, grain exports are carried out by intermediary structures that do not participate in the production process, but take all the additional income from its sale, which is extremely unfair to grain producers. Grain is a universal product that ensures the food security of any country and affects the formation and development of food markets. For many agricultural producers, it occupies a significant share in the total revenue from its sale, and most farms are engaged only in grain cultivation [12]. Grain is a universal product that ensures the food security of any country and affects the formation and development of food markets. For many agricultural producers, it occupies a significant share in the total revenue from its sale, and most farms are engaged only in grain cultivation.

There are also many questions in the pricing of dairy products. Milk production occupies a large share in the gross agricultural output, and its economic efficiency largely determines the efficiency of the entire agricultural sector [13]. Russia is not yet able to provide the population with sufficient dairy products, so the Food Security Doctrine provides for increasing the country’s self-sufficiency in milk and dairy products to 90% [14].

Milk production is a labor-intensive industry and it is difficult for milk producers to adapt to changes in market conditions, this industry is characterized by significant seasonal price fluctuations. In the chain from producer to processor and seller, milk increases its initial value by approximately 150%. About 80% of this profit is received by the processor. The retail seller's margin for wholesale purchases is on average about 60% and only 10% of the profit falls directly on the manufacturer.

It is especially difficult for peasant farms, for which cases often arise when they find themselves in conditions of uncertainty. As a rule, they use outdated equipment in the production process, the product range is represented by one or two names, which undoubtedly affects the quantity and quality of the products produced [15].

Agriculture operates in unequal conditions compared to other areas of the agro-industrial complex and industries. Price disparity is one of the acute problems inherited by agriculture from the Soviet era, and in the conditions of market relations, it has only become even more acute. The price disparity has become permanent and stable. Moreover, if crop production is mostly a profitable industry, then in animal husbandry, due to high costs, there is a low profitability, and often unprofitability.

In the past year, in the context of the coronavirus, the agricultural sector in Russia was the least affected by the pandemic. According to Federal State Statistic Service, the average retail prices for milk and dairy products for the six months of 2020 increased by 5.4%, buckwheat increased by a record 38 %, carrots – by 17 %, pasta and potatoes – by 14 %, slightly less, but prices for other products also increased. This is certainly not bad for product manufacturers, but on the other hand, prices for consumers, whose incomes have significantly decreased due to inflation, have also increased, and material and technical resources are becoming more expensive. The situation remains quite complicated. In any case, the income of the population of the country should allow them to purchase the necessary food products at the offered prices and in those quantities that correspond to medical consumption standards [16]. It is necessary to ensure physical access to food, which implies access to food throughout the country at any time and in the necessary assortment, as well as economic access, according to which the income of any citizen should allow him to purchase food products not lower than the minimum level of consumption [17]. Therefore, when forming prices for agricultural products and products of its processing, it is necessary to take into account the solvency of the population.
3. Experimental part

Pricing is one of the most important business processes in any organization or company. An important point is the choice of the pricing method, which depends on the purpose of the enterprise and should correspond to its specialization. If the task is to increase the volume of products sales, it is advisable to use market pricing methods. If it is necessary to set prices for new products, then it is necessary to apply cost-effective methods.

The authors suggest a method of reducing the price taking into account the existing state of the agricultural organization in order to avoid financial losses under the following conditions:

- when entering the market of competitors with a similar product of improved quality;
- when there is a glut of demand in the market for these products;
- when the price is deliberately lowered by competitors to expand the market niche.

In order to determine the value of a possible discount on the price, it is necessary to calculate the maximum possible price change. In our opinion for this purpose it is necessary to perform a number of calculations according to the presented algorithm:

\[
\Delta C = \left( \frac{W_b}{Q_b} + \frac{W_c}{Q_c} \right) - \left( \frac{W_b}{Q_b} + \frac{W_c}{Q_c} - P \right) \cdot \Delta \delta
\]  

(1)

\(\Delta C\) – maximum price change; \(W_b\) – revenue indicators at a break-even point; \(W_c\) – maximum conditional value of the monthly revenue; \(Q_b\) – indicator of monthly sales volume at the break-even point; \(Q_c\) – the maximum value of the monthly sales volume of the previous year.

\[
W_i = W_b \cdot \Delta s
\]  

(2)

\(\Delta s\) – ratio of revenue at the maximum sales volume according to the equation of the polynomial trend line to revenue at the break-even point; \(W_i\) – revenue at maximum sales volume; \(W_2\) – revenue at break-even point.

\[
P = C \cdot 0.01 \cdot p
\]  

(3)

\(C\) – price at break-even point; \(P\) – price reduction; \(p\) – percentage of price reduction, determined from table 1.

| Table 1. Percentage of price reduction based on the value of the deviation coefficient. |
|-----------------------------------------------|-----------------------------------------------|
| Indicator | Price reduction at the value of \(\Delta \xi\) |
|-----------|-----------------------------------------------|
|           | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | 100 |
| Price reduction (p), % | 0 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

\(\Delta \xi\) – coefficient of the average salary deviation in the municipality \(\xi_2\) where sales are made to the average salary in the country \(\xi_1\).

\(\Delta \delta\) – deviation coefficient of the arithmetic mean of the considered indicators from the arithmetic mean of the trend line indicators.

Taking into account a certain value of the maximum discount, we plot the dependence of the discount on the price and the quantity of products sold.

In the presented graph, the functional dependences of changes in the amount of income growth and prices (discounts) are performed based on the study of the previous period indicators and the construction of a linear trend line, assuming that the indicators did not change in the period under review.
Initially, it is known that the multiplication of the sold products on the price will give the value of revenue, therefore, according to the graph (figure 1) the area of the triangle ABC bounded by the equation of the direct price reduction $Y = (f_1) x$ multiplied by 2 will be the value of revenue. The area under consideration, bounded by the equation of the direct price reduction multiplied by 2, will correspond to the value of the maximum increase (decrease) in revenue:

$$\Delta V = 2 \cdot F_1 \quad (4)$$

$V_{\text{max}}$ – maximum revenue growth.

$$F_1 = 0.5 \cdot Y_{2\text{max}} \quad (5)$$

$Y_{2\text{max}}$ – maximum value of the price reduction.

However, if the price decrease has different values, in this case the maximum value of the revenue increase will be determined as follows:

$$F_1^* = \int_0^{x_{\text{max}}} \left( f_1 \right) dx \quad (6)$$

$f_1$ – equation of the trend line of the change in the price increase to the increase in the volume of products sold for the period under consideration (previous year).

The growth of the indicator in question in each month is defined as the difference between the monthly indicator and the average indicator for the previous year. The equation for the relationship of the dynamics of monthly growth rates is built using the Microsoft Excel program of the LINEST statistical function.

$$\Delta V = 2 \cdot F_1^* \quad (7)$$

$$\Delta M_{\text{max}} = 2 \cdot F_2 \quad (8)$$

$\Delta M_{\text{max}}$ – maximum increase in income.

$$F_2 = 0.5 \cdot Y_{1\text{max}} \cdot X_{\text{max}} \quad (9)$$

$Y_{1\text{max}}$ – the maximum value of the increase in income per 1 unit of production.

Based on the obtained values of the maximum increase in revenue and profit, you can determine the conditional value of the maximum increase in costs ($\Delta S$) and the maximum increase in return on sales ($\Delta H$):

$$\Delta S = \Delta V_{\text{max}} - \Delta M_{\text{max}} \quad (10)$$
If the indicators of the actual increase in output and the decrease in price during the year did not have the same value, then these indicators are determined by the trend line of the equation of the dependence of the increase in the number of products on the decrease in price and on the change in the increase in income (loss):

$$\Delta S = 2\left(\int_0^{\text{max}} f_1(x) \, dx - \int_0^{\text{max}} f_2(x) \, dx\right)$$

$$\Delta H = \frac{\Delta M_{\text{max}}}{\Delta V_{\text{max}}} \cdot 100\%$$

4. Results and discussion

An important condition for increasing product sales is the correct ratio of price to additional costs per unit of production and the amount of additional products sold. The influence of these parameters is considered on the graph, where the following patterns can be identified.

The graph shown in figure 2 shows that with an increase in the market niche, additional costs are needed to promote additional products, so with an additional increase in the number of products, costs increase. It shows that when the price decreases, the number of products sold increases. The intersection of the price change line with the line of additional costs will give the point of optimal increase in the sale of additional products.

To determine its value, it is necessary to use the formulas:

a) Based on the equation of direct additional costs in figure 3, the value of the optimal amount of additional production \( (H_0) \) will be determined as follows:

$$Y = (f_i) \cdot x$$

![Figure 2. Graph of the impact of price changes and costs on the number of additional products sold.](image)

![Figure 3. Graph of the impact of the additional products sold number on changes in costs.](image)
b) Based on figure 3, put the coordinates of the starting points A, B, and C in the equation of the straight line, taking into account the maximum values of the cost of additional expenses and the number of additional products:

\[
\frac{x_0-0}{x_{max}-0} = \frac{y_0-0}{y_{max}-0}
\]  

(13)

c) From the resulting equation, express the value of the optimal amount of additional production and the amount of additional costs:

\[
X_0 = \frac{y_0x_{max}}{y_{max}} ; \quad y_0 = \frac{x_0y_{max}}{x_{max}}
\]  

(14)

Consider the use of the suggested algorithm on the example. For the past period, the maximum cost per unit of additional products sold per month was 20 rubles. It is expected to increase the volume of products sales by 50 units. At the same time, the maximum increase in production in the last period was 100 units per month. Determine the possible additional costs. Solution: \(Y_0 = \frac{50 \cdot 20}{100} = 10\) rubles per product unit.

Based on the presented calculation, the cost per unit of production will increase by 10 rubles along with an increase in production by 50 units:

a) Based on the equation of the straight line in figure 4, the optimal quantity of products at the set value of the price change can be determined as follows:

\[Y_{cost} \]

\[C (0;Y_{max}) \]

\[B (X_o;Y_o) \]

\[C (X_{max};0) \]

\[X (number \ of \ additional \ products \ sold) \]

\[X_0 = \frac{y_0x_{max}}{y_{max}} \]

\[y_0 = \frac{x_0y_{max}}{x_{max}} \]

Figure 4. Graph of the impact of price changes on the number of additional products sold.

b) Based on figure 4, we put the coordinates of the starting points A, B, and C into the equation of the straight line, taking into account the maximum values of the price change and the amount of additional products:

\[
\frac{x_0-x_{max}}{0-x_{max}} = \frac{y_0-0}{y_{max}-0}
\]  

(15)

c) From the resulting equation, we express the value of the additional products optimal amount based on the price change:

\[
X_0 = x_{max} - \frac{y_0x_{max}}{y_{max}}
\]  

(16)

Consider the use of the suggested algorithm on the example. The maximum difference in the price of products on the market is 5 rubles. The volume of products sold during the year is 200 units per month at the price of 40 rubles per unit. It is suggested to increase the sales volume by 50 units and reduce the price of products by 2 rubles. Determine the optimal volume of production per month. Solution: \(X_0 = 50 - \frac{2 \cdot 50}{5} = 30\) units.
5. Conclusion
The presented methodology is based on taking into account changes in price indicators for the considered period of time and integrating the equation of the functional dependence of price changes to changes in the volume of products sold. The presented approaches in the article are recommended to be applied under the following conditions in agricultural activity: competitors entering the market with a similar product of improved quality, with an oversaturation of demand in the market of this product, with a deliberate price reduction by competitors to expand the market niche, which will allow them to flexibly respond to changes in the market conjuncture of agricultural products. With an increase in the production of agricultural products provided for by Food Security Doctrine, this technique will allow entering the existing market with additional products with less losses. Also, these approaches make it possible to use them as tools for planning and forecasting the production and marketing activities of agricultural organizations and within the framework of state regulation of rural development.

The approaches to pricing and assessing the effectiveness of product sales presented in the article are relevant for the development of agribusiness in any country in the world, allowing an agricultural producer to see the possibilities of reducing prices and to determine the profitability of sales, taking into account the dynamics of changes in prices and the volume of products sold. Ultimately, this will make it possible to increase the efficiency of agribusiness and to consolidate the able-bodied population in rural areas.

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