

MATHEMATICAL METHODS FOR EVALUATING THE EFFECTIVENESS OF ADVERTISING IN AGRICULTURAL PRODUCTION

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ABSTRACT

Successful financial activity of agricultural enterprises significantly depends on their advertising campaign. The article investigates the method of assessing the effectiveness of advertising in agricultural production as a type of psychological impact on the consciousness and behavior of potential consumers. It is noted that different models of influence are used in the process of developing modern agricultural advertising products. The system of the main factors influencing efficiency of advertising in the agrarian sphere, their ways of calculation and the economic meaning are considered. Article provides examples of usage the mathematical methods for assessing the effectiveness of advertising in agricultural production, which provide opportunities to timely use tools to improve the effectiveness of advertising levers in the activities of agricultural enterprises.

Keywords: psychological influence, economic effect, models, logistic curve, agrarian sphere, quadratic dependence, differential equation.

INTRODUCTION

Advertising is considered as a highly effective means of competition of agricultural enterprises in market conditions. After all, the advertising company and the new requirements for the work of agro-industrial enterprises significantly affect the results of their successful activities, which cause significant changes in the management mechanism, forms of ownership, the nature of relations between producers and consumers in the organization of advertising.

Examining the practical functioning of agricultural enterprises, we can note the lack of an effective mechanism for advertising, focused on ensuring the competitiveness of the enterprise.

Given this, there is a need to study the agricultural market, forecast development, analysis of marketing activities of enterprises and the formation of reserves for growth of their profitability by increasing the effectiveness of advertising in the system of marketing activities in an unstable business environment.

RESEARCH METHODS

In studying the advertising activities of agricultural enterprises and its means of interaction with the market environment, a systematic approach and methods of synthesis and mathematical statistics were used.

RESULTS AND DISCUSSION

The term "advertising" can mean advertising as a product or as a process of manufacturing this product. Advertising as a product is a form of presenting information about a particular manufacturer's products. It is a separate tool of marketing communications, the purpose of which is

to establish links between consumers and producers of goods. Basic principles of advertising: creating, maintaining and deepening the image of the company and its products; motivating the buyer to buy the product; increasing the market segment of goods produced by the enterprise.

In order for advertising communication to achieve its goal, it is necessary to ensure the conditions for its effectiveness. Efficiency is determined by a system of indicators: sales of goods, net profit, production cost ratio, rate of return on invested capital, and so on. In modern market conditions, the efficiency of agricultural enterprises involves the use of a set of marketing tools, including advertising communications, and it is worth focusing on the effectiveness of advertising as an important condition for competitiveness of enterprises.

The process of advertising influence is constantly changing and requires appropriate scientific evaluation. The lack of an effective methodology for assessing the effectiveness of advertising encourages the study of new diverse approaches to optimize the process of advertising impact, to consider it in both dynamic and static conditions. The above mentioned necessitates the study. The mechanism of formation of advertising activity of agricultural enterprises in the context of ensuring their competitiveness in an unstable market environment is the object of study.

The purpose of advertising appeal - to ensure the stages of effectiveness of advertising. In the case that the advertiser independently develops an advertising appeal and conducts an advertising campaign, the structure of the advertising process will consist of the following stages:

- research of goods and services of the enterprise, competitors, buyers and sellers;
- definition and development of the purposes of advertising communication which should proceed from the general purposes of the enterprise;
- development of the budget of the advertising campaign;
- defining the concept of the advertising campaign;
- choice of means of advertising;
- specification of tasks;
- choice of forms of advertising appeals;
- development of a business plan for an advertising campaign;
- creation of advertising appeals;
- placement of advertising appeals;
- control over the course of the advertising campaign (measuring effectiveness) and adjustment as needed;

The effectiveness of advertising is influenced by factors of direct and indirect action, the most important of which are the objectivity of advertising messages, the specifics of the market of advertised goods, advertising opportunities, national characteristics of the target audience, the amount allocated for advertising activities. Thus, advertising in the agricultural sector has a significant impact on increasing sales, providing information about agricultural products, their promotion, increasing demand, turnover and production. It is an integral and active part of a comprehensive system of marketing activities of enterprises, the level of development of which is determined by the quality and effectiveness of advertising campaigns in accordance with the requirements of the modern market.

Advertising stimulates the development of economic processes, revives the market, increases agricultural output, consumer demand and reduces the unit cost. Thus, the increase in demand leads to increased production and cheaper products, market saturation, increased corporate profits, increased contributions to the state budget, higher wages, job creation, strengthening the socio-economic situation in the country. It should be noted that advertising in the agricultural sector stimulates the satisfaction of new needs of buyers, and this gives a new impetus to production, determines the direction and pace of its development [1]. Examining in detail the advertising activities of agricultural enterprises and studying the scientific works of scientists, we can conclude that it consists in creating an advertising product, bringing it to potential buyers so that they

understand what exactly the product, service or idea is positively different from similar , and the manufacturer was able to turn this innovation into capital [2].

Of course, advertising services are an expensive procedure, they require significant investment, and if advertising measures are not stimulated financially, not supported, then the sale of products, agricultural production will be slowed down, higher costs per unit of production will be determined.

Advertising strategy in agricultural production as a type of psychological impact on the consciousness and behavior of potential consumers, should take into account a set of factors, which are presented in Figure 1.

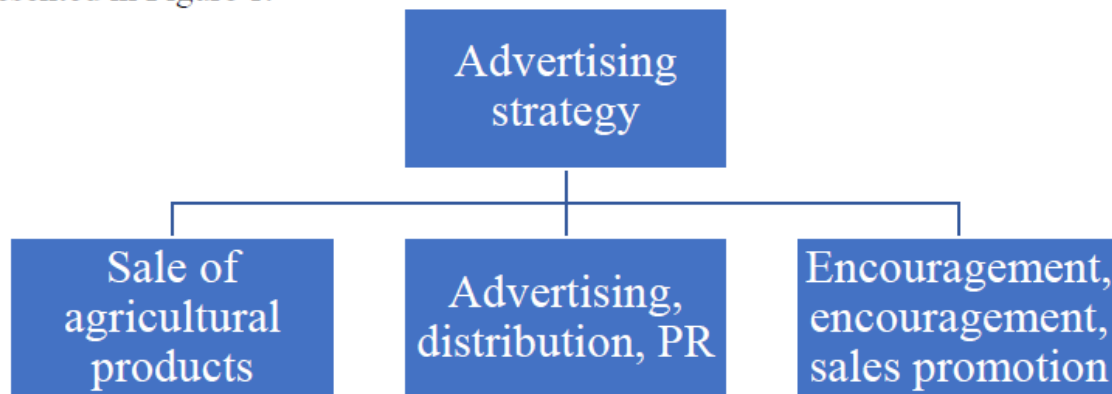


Fig. 1. Factors of advertising strategy of agricultural enterprises

The process of forming the advertising strategy of agricultural enterprises covers all the main communication tools, therefore advertising should be considered as a tool for implementing the marketing and business strategy of farmers. The integration of marketing communications (advertising, public relations, sales promotion, direct sales, sponsorship, direct marketing, merchandising) is necessary, as they must all be aimed at achieving one goal. Advertising communication should have the features of a logical process, timely delivery of messages to the consumer, to form his support and love for the brand of agricultural products. All this will increase the profitability of enterprises, increase the effectiveness of advertising.

In order to increase market share and increase the price of products, agricultural enterprises have the opportunity to increase the value of their own brand. It is worth noting that advertising should be large-scale, long-term and continuous for its effectiveness, the interest of a wide range of consumers, constantly updating and attracting new audiences, otherwise you can quickly lose everything.

And the implementation of these requirements is very much in need of funding, avoidance of unnecessary costs, planning and implementation of the advertising budget, real and meaningful justification of the required level of costs for the promotion and sale of advertising agricultural products.

Analyzing the methods of advertising, we often see advertising products on national TV channels, in supermarkets, in crowded places, in markets. Advertising messages for the target group of consumers must take into account a set of competitive advantages that are important for the selected audience (product quality, nutritional properties, wide range, attractive packaging, high quality guarantees). It is necessary to stimulate intermediaries, to encourage working staff to improve service to build a reputation for high quality healthy agricultural products, which has no competition.

Studying consumers in our country, we can state their traits such as nationalism, practicality, principles, values, love of work on earth, distrust of others or new, friendliness, solidarity, friendliness, you can take into account when developing advertising campaigns, their psychological characteristics and ability perception of advertised information.

Thus, for planning and decision-making on advertising, the main attention should be paid to market analysis and motivation of consumer behavior regarding the choice of products offered. The organization of marketing will ensure the rational management of production and marketing activities of agricultural enterprises, the development of market relations and, above all, the

orientation of the market of agricultural products to consumer demand, which is one of the main conditions for effective development of agro-industrial production.

The effectiveness of the company's advertising activities determines its level and compliance with modern market conditions. Analysis of recent research shows that the successful financial performance of enterprises depends significantly on their advertising company [3, p.623]. The effectiveness of the use of advertising technologies in different years was paid attention to the following scientists: F. Kotler, KL Keller, J. Daly, T. Ambler.

Term "economic efficiency" is interpreted by authors as the ratio of the company's costs for advertising for a specific period of time to the results obtained from advertising. To assess the effectiveness of advertising traditionally use a system of indicators:

1. The increase in sales obtained under the influence of advertising over a period of time:

$$V_{\text{доо}} = (V_{c2} - V_{c1}) \times D \quad (1)$$

where, V_{c1} , V_{c2} - the average daily turnover before and after advertising,
 D - the period during which determine the increase in turnover.

2. Economic effect of advertising:

$$E_p = V_{\text{доо}} - (B_p + B_n) \quad (2)$$

where B_p - advertising costs, B_n - additional costs associated with sales growth.

3. Profitability of advertising (%):

$$P_p = \frac{\Pi}{B_p} \times 100 \quad (3)$$

where Π - the profit received as a result of advertising of the goods.

4. The ratio of sales per 1 monetary unit of advertising costs:

$$K_p = \frac{V_p}{B_p} \quad (4)$$

where V_p - the volume of sales of goods after advertising.

5. Coefficient of advertising costs per 1 monetary unit of sales volume:

$$K_p = \frac{B_p}{V_p} \quad (5)$$

6. Coefficient of efficiency of expenses for advertising:

$$K_{\kappa} = \frac{V_1}{B_{p1}} \times \frac{V_2}{B_{p2}} \quad (6)$$

where V_1 V_2 - the volume of sales of goods of the 1st and 2nd firms for a specific period.

In order to develop methods of using mathematical methods to assess the effectiveness of advertising, as additional, as the company does not always have the necessary data to calculate the above indicators, we will continue our research. The concept of advertising effectiveness includes the content of such factors as economic, psychological and social effects. It is advisable to use differential equations to measure the communicative effectiveness of advertising.

Authors consider the task that [7, p.547] enterprises sell products B , about which at time t of the number of potential buyers N knows only x buyers. Suppose further that to accelerate the sale of products B were provided advertisements on radio and television. The following product information is disseminated to customers through communication with each other.

We will assume that after advertisements the rate of change in the number of consumers who already know about the product B is proportional to both the number of buyers who know about the product and the number of buyers who did not know about it.

Assuming that the time is counted after the advertisements, when $\frac{N}{\gamma}$ men are informed about the product, we come to a differential equation with separable variables.

$$\frac{dx}{dt} = kx(N - x) \quad (7)$$

with initial conditions $x = \frac{N}{\gamma}$, if $t=0$.

In equation (7), the coefficient k - is the coefficient of proportionality. We give equation (7) in the form:

$$\frac{dx}{x(N - x)} = k dt$$

From here we get

$$\int \frac{dx}{x(N-x)} = k \int dt + c, \text{ or}$$

$$\frac{1}{N} \int \left(\frac{1}{x} + \frac{1}{N-x} \right) dx = k \int dt + c.$$

After integration we will have

$$\frac{1}{N} (\ln|x| - \ln|N - x|) = kt + c$$

$$\frac{1}{N} \ln \frac{x}{N - x} = kt + c$$

Assuming $Nc = c_1$, we arrive at the equality:

$$\frac{x}{N-x} = Ae^{Nkt}, \text{ where } A = e^{c_1}$$

If we solve the last equation with respect to x , then we obtain the relation

$$x = N \frac{Ae^{Nkt}}{Ae^{Nkt} + 1} = \frac{N}{1 + Pe^{-Nkt}}, \text{ where } P = \frac{1}{A}.$$

In the economic literature, this equation is called the equation of the logistics curve.

If we take into account the initial conditions, we obtain the equation:

$$\frac{N}{\gamma} = \frac{N}{1 + Pe^{-Nk \cdot 0}}, \text{ where } P = \gamma - 1$$

$$\text{or } x = \frac{N}{1 + (\gamma - 1)e^{-Nkt}} \quad (8)$$

A similar equation reduces, in part, the problem of the distribution of technological innovations. One way to measure the commercial effectiveness of advertising is to compare sales with advertising costs for previous periods.

Authors consider the task [7, p.512]: in the researched agricultural enterprise (which develops advertising of its agricultural products) there are data on advertising costs x (UAH units) and sales volumes of agricultural products y (UAH units). The initial data are presented in table 1.

Table 1. Initial data on the cost of advertising and sales

Advertising costs (x) i, (UAH per unit)	1	2	3	4	5
Sales volumes (yi), (UAH per unit)	1,6	4,0	7,4	12,0	18,0

Assuming that there is a quadratic dependence between the variables x and y , which has the following form: $y = ax^2 + bx + c$, it is necessary to find the values of the parameters a, b, c by the method of least squares, for this we perform calculations, and their results are given in table 2.

Table 2

The results of calculations

i	x_i	y_i	x_i^2	x_i^3	x_i^4	$x_i y_i$	$x_i^2 y_i$
1	1	1,6	1	1	1	1,6	1,6
2	2	4,0	4	8	16	8,0	16,0
3	3	7,4	9	27	81	22,2	66,6
4	4	12,0	16	64	256	48,0	196,0
5	5	18,0	25	125	625	90,0	450,0
Σ	15	43,0	55	225	979	169,8	680,2

The parameters are found from the system of normal equations, which are presented below (9)

$$\begin{cases}
 a \sum_{i=1}^n x_i^4 + b \sum_{i=1}^n x_i^3 + c \sum_{i=1}^n x_i^2 = \sum_{i=1}^n x_i^2 y_i \\
 a \sum_{i=1}^n x_i^3 + b \sum_{i=1}^n x_i^2 + c \sum_{i=1}^n x_i = \sum_{i=1}^n x_i y_i \\
 a \sum_{i=1}^n x_i^2 + b \sum_{i=1}^n x_i + cn = \sum_{i=1}^n y_i
 \end{cases} \quad (9)$$

$$\begin{cases}
 979a + 225b + 55c = 680,2 \\
 225a + 55b + 15c = 169,8 \\
 55a + 15b + 5c = 49,0
 \end{cases}$$

The solution of this problem is as follows: $a = 0,3$, $b = 0,18$, $c = 5,06$. Thus, the dependence we are looking for has the form $y = 0.3x^2 + 0.18x + 5.06$. The obtained model, while maintaining the trends, can be used in the study of ensuring the effectiveness of advertising in agricultural production to develop practical recommendations for improving the effectiveness of advertising. The considered mathematical methods can be used for an estimation of advertising activity that gives the chance to take timely measures for increase of its efficiency.

We will compile an algorithm for analyzing the effectiveness of advertising and present in Figure 2.

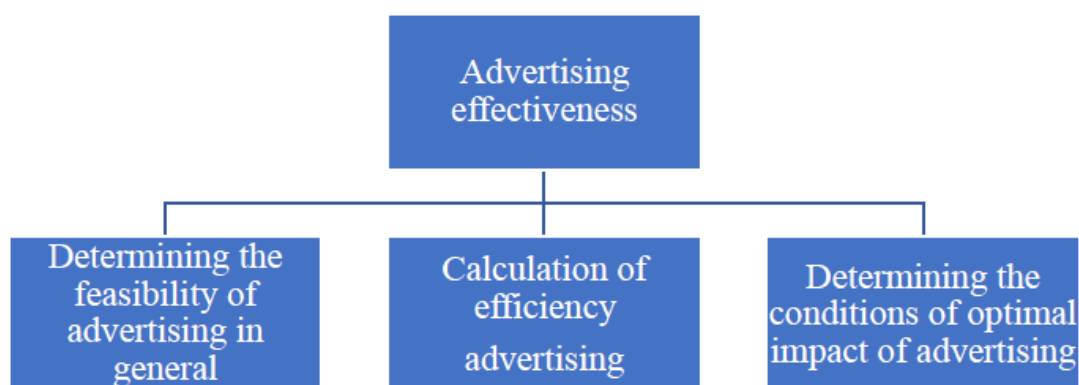


Fig. 2. Algorithm for analyzing the effectiveness of advertising

The above algorithm contains components - the main factors influencing the effectiveness of advertising in the agricultural sector. Determining the feasibility of advertising in general - their main factor - economic indicators; calculation of the effectiveness of the advertising event - mathematical methods; determining the conditions for the optimal impact of advertising - social and psychological components.

CONCLUSION

Based on the results of research, we can conclude that the most important basis for advertising of agricultural enterprises are the specifics of the agricultural market, opportunities for advertising, features of a wide range of consumers, the effectiveness of advertising, the amount allocated for advertising activities.

All these measures require large financial costs for advertising and production of the advertising product, as well as the development of special measures aimed at improving their marketing activities and increase the competitiveness of agricultural products in the face of increased competition and shortage of raw materials.

The system of main components, factors influencing the effectiveness of advertising in the agricultural sector, their methods of calculation and economic content are considered. It is proved that decisions in the field of advertising are made in conditions of certain risk and uncertainty. The considered methods provide an opportunity to predict the impact of advertising in the agricultural sector. Achieved goal - to identify a set of conditions and factors that affect the effectiveness of advertising in agricultural production.

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