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### Increasing the Multiplier Effect of the Agro-Industrial Complex in the Northern Region: New Guidelines for Strategic Development \*

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**Abstract.** The article discusses the problems of increasing the multiplier effect of the agro-industrial complex of the Komi Republic as a result of investment, as well as ways to accelerate the economic growth of its spheres and individual enterprises. The problems of motivation to increase capital investments in order to increase production and competitiveness of marketable products remain without due attention. The aim of the study is to substantiate the transition of the agro-industrial complex of the Komi Republic to an innovative and investment path of development, to more active methods of using advanced technologies and resource provision of investments, increasing the share of the intellectual component in their composition. The subject of the study is to determine the level of the multiplier effect of the agro-industrial complex of the Komi Republic as a method for assessing its effectiveness and competitiveness. Research methods — quantitative assessment of the effectiveness of total costs, scientific abstraction, analysis and synthesis, systems approach, historical and logical method, statistical observations. The article reveals the main trends of the multiplier effect in the agro-industrial complex of the Komi Republic. It is proposed to increase the multiplier effect of the agro-industrial complex for business entities to focus on the tasks of coordinating the flows of available investment resources.

**Keywords:** *Agro-industrial complex, Komi Republic, strategy, investment, output, multiplier effect, competitiveness, efficiency, growth, ratio.*

#### Introduction

We proceed from the position that the multiplier effect regulation of the agro-industrial complex of the region contributes to its sustainable long-term development and eliminates random errors in the long-term strategic development of agro-industrial spheres.

Due to the spread and strengthening of the digital economy within the agro-industrial complex in the Komi Republic, the high level of competition in the regional food market, instability in the world ones and Western sanctions against the Russian Federation, investors' uncertainty about the effectiveness of their investments increases. The relevance of their request to assess the multiplier effect of investment in the agro-industrial complex of the Komi Republic is growing.

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We proceed from the assumption that investments are a basic element in the development of the agro-industrial complex of the Komi Republic, a key factor in increasing its share in meeting the needs of the population in food, improving its competitiveness and strengthening the financial stability of organizations of the regional agro-industrial complex. In this regard, the increase in the multiplier effect (multiplier coefficient) of the agro-industrial complex (AIC) of the region is one of the indicators of its investment climate.

We understand the multiplier effect as the dependence between the increase in gross product (gross income) of an economic unit and the increase in investment. Quantitatively, the multiplier effect is expressed through the investment multiplier — a coefficient reflecting the ratio between the volume of output or income received, on the one hand, and the amount of investment, on the other hand. As a rule, the multiplier is more than one.

The analysis of the multiplier effect of investments allows to determine the directions of more effective use of investments by identifying the competitive advantage of investments, improving the coordination and organizational components of economic activity, enhancing the balance of capital, land, climatic, labour and marketing resources.

Estimation of multiplier effect of investments involves generalization or detailed elaboration of consistently arising investment cycles, which allows increasing the level of regulatory activity of the state and business organizations in market processes.

In the regulation of market processes aimed at eliminating spontaneous and unforeseen violations of the proportionality of material and cash flows, the most important role is assigned to the regulation of proportionality between production potential and output. An emphasis on output leads to its decline in the long term, while an emphasis on potential leads to a slowdown in the turnover of capital and working capital of economic organizations. Ultimately, the imbalance between capacity and output leads to instability in the commodity, financial and labour markets.

We agree with O. Melyukhina and I. Khramova that regional food markets are currently facing the loss of mutually beneficial ties at the regional level between producers and buyers of food products due to territorial specialization of production, improvement of transport and supply and marketing infrastructure, enhancement of storage conditions of food resources [1, Melyukhina O., Khramova I., p. 398].

In our opinion, the strategy of investment development of the Komi Republic up to 2035 is developed in a fragmented way. In addition to geological exploration and mining, the key areas of development of the Komi Republic include the development of agriculture and farming<sup>1</sup>. The following districts with a promising specialization in the sphere of agro-industrial complex have been identified: municipal district (MD) “Kortkerosskiy”, MD “Systsolskiy”, MD “Koigorodskiyy”, MD “Syktyvdinskiy”. The Strategy sets the goal to form a strong economy with an attractive investment

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<sup>1</sup> O strategii sotsial'no-ekonomicheskogo razvitiya Respubliki Komi na period do 2035 goda. Postanovlenie Pravitel'stva Respubliki Komi ot 11 aprelya 2019 g. № 185 [On the Strategy of Socio-Economic Development of the Komi Republic for the Period up to 2035. Decree of the Government of the Republic of Komi dated April 11, 2019 No. 185].

climate in the region. The task was set to increase the level of self-sufficiency of the Komi Republic in basic foodstuffs with an appropriate level of quality and safety to the following levels: milk and dairy products — 35.3%, meat and meat products — 47.7%, potatoes — 100%, vegetables — 38.7%, the preservation of the reindeer livestock in agricultural organizations is expected to be at the level of 21 thousand. However, investments in the agro-industrial complex of the region have been determined without proper detailing and coordination across regions.

An assessment of the multiplier effect from investments in the agro-industrial complex of the region will contribute to a more complete version of the Investment Development Strategy of the Komi Republic.

### ***Literature review on boosting and spreading of economic growth during the investment cycle, investment multiplier and accelerator***

Thomas Aquinas saw the fulfillment of social and religious duties as an impetus for the growth of wealth [2, Thomas Aquinas].

Mercantilists considered trade to be the main factor of economic growth. The difference between the inflow and outflow of gold specifies the relationship between the impetus and the spread of economic growth in trade itself [3, Lapteva E.V.].

Physiocrats saw the relationship between the impetus and the spread of economic growth in the growth of land productivity [4, Drozdov V.V.], A. Smith — in the division of labour, as well as in the absolute and relative advantages of exchange [5, Smith A., p. 110].

K. Marx defined the impetus of capitalist economic growth as the desire of capitalists to increase profits and increase the output of means of production in order to attract more workers [6, Marx K., Engels F., p. 596].

G.A. Feldman believed that the growth rate of national income is determined by capital expenditures for expanding production and their ability to increase the volume of national income according to the formula:

$$T = \frac{dH\Delta}{dt} \cdot \frac{I}{H\Delta}, \text{ where (1)}$$

T = economic growth rate;

$dH\Delta$  — increase in national income per unit of time;  $dt$  — time;  $I$  — investments in the expansion of production;  $H\Delta$  — national income.

The rate of economic growth is directly proportional to the effect of investments and the share of investments in national income [7].

M. Kalecki proposed the following formula for revealing the nature of the economic growth impetus:

$$P+W = C_w + C_p + I, \text{ where (2)}$$

$P$  — gross profit of capitalists;  $W$  — total wages of workers;  $C_w$  — consumption of workers;  $C_p$  — consumption of capitalists;  $I$  — investments in the expansion of production.

The gross income of society is divided into consumption of capitalists, consumption of workers and investment [8, Kalecki M.]

At the centre of Frisch's analysis of national economic growth is the multiplier-accelerator. The multiplier expresses the causal relationship between the initial change in investment and subsequent changes in demand. The equation in the relationship between national income and investment is as follows:

$$Y_t = cY_{t-1} + I_t, \text{ where (3)}$$

$Y_t$  — income in period  $t$ ;  $c$  — coefficient of propensity to consume;  $I_t$  — investment in the period  $t$  in the expansion of production.

Changes in capital investment cause changes in income.

The consumption equation is as follows:

$$C_t = cY_{t-1}, \text{ where (4)}$$

$C_t$  — consumption in period  $t$ ;  $c$  — coefficient of propensity to consume (share of consumption in national income);  $Y_{t-1}$  — national income in the previous period.

According to the principle of acceleration, any increase / decrease in income causes an increase / decrease in capital investments. Formally, it can be written as follows:

$$I_t = v(Y_t - Y_{t-1}), \text{ where (5)}$$

$I_t$  — investment of the period  $t$ ;  $v$  — acceleration coefficient, based on the marginal capital / product ratio according to the production function.

The combined action of the multiplier and the accelerator can be written as follows:

$$Y_t = cY_{t-1} + I_t + v(Y_{t-1} - Y_{t-2}) \text{ (6)}$$

The formula for the combined action of the multiplier and the accelerator shows that the income dynamics has a wave-like character. When  $v = 1$ , the oscillations are uniform, at  $v > 1$ , the oscillations become stronger, at  $v < 1$ , the oscillations become fainter.

The multiplier-accelerator mechanism reflects a hypothetical economy which is far from the real one [9].

J. Hicks believes that fluctuations in income growth are uniform, since income movements in any direction cannot continue indefinitely. They run into barriers that income cannot cross. Income reaches the maximum level, is pushed away from it and starts moving in the opposite direction [10, Hicks J.R.].

E. Domar characterizes the relationship between the impetus and the spread of economic growth by the equation:

$$\frac{Y_{t+1} - Y_t}{Y_t} = \frac{I_{t+1} - I_t}{I_t} = \alpha\sigma \text{ (7)},$$

where

$Y$  — income;  $t$  — period;  $I$  — investment;  $\alpha$  — marginal propensity to save;  $\sigma$  — potential average public investment productivity.

The growth rate of national income is directly proportional to the product of the marginal propensity to save and the average productivity of investment [11, Domar E.].

R.F. Harrod's model of the impulse and spread of economic growth is as follows:

$$\frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{Y_{t-1} - I_{t-2}}{Y_{t-2}} = \frac{S}{C_r - S}, \text{ where (8)}$$

$Y$  — income;  $t$  — period;  $S$  — increase in production capabilities per unit of investment;  $C_r$  — marginal capital / product ratio.

There is a limit to income growth that, once achieved, tends to be constantly reproduced. However, if this tendency is violated, the equality of supply and demand is also violated.

In R. Solow's model, employment growth is taken as the impetus for economic growth. The economy strives for full employment and thus causes economic growth. Formally, R. Solow's model has the following form:

$$\frac{dK}{dt} = s F(k, 1) - nk, \text{ where (9)}$$

$\frac{dK}{dt}$  — capital growth per unit of time;  $s$  — savings rate;  $F(k, 1)$  — output per person employed;  $n$  — growth in number of workers;  $k$  — capital per person employed.

The increase in capital due to employment growth is directly proportional to the productivity of one worker and the savings rate adjusted for the growth in the number of workers and the amount of capital per worker.

The savings rate that gives the maximum consumption level is called the optimal savings rate. The formula for the optimal savings rate is as follows:

$$s^* = \frac{k^{**}}{f(k^{**})} \cdot \frac{df(k^{**})}{d(k^{**})}, \text{ where (10)}$$

$s^*$  — optimal savings rate;  $k^{**}$  — capital-to-labour ratio per unit of effective labour;  $k$  — amount of capital per employee.

The optimal savings rate is equal to the capital elasticity of output.

In the long term, the main factor of economic growth is the development of machinery and technology. It gives an increase in the efficiency of labour and capital without an increase in employment [12, Solow R.M.].

In J. Mead's model of economic growth, savings are the result of economic growth. The model has the following form:

$$\frac{sY}{K} = \frac{Ql+r}{1-U}, \text{ where (11)}$$

$sY$  — savings;  $k$  — capital;  $l$  — labour growth rate;  $r$  — growth rate of national income, determined by the formula

$$r = \frac{\Delta Y}{Y}, \text{ where (12)}$$

$r$  — growth rate of national income;  $\Delta Y$  — increase in national income;

$Y$  — national income;  $Q$  — total labour product.

It is determined by the formula:

$$Q = \frac{F_L L}{Y}, \text{ where (13)}$$

$F_L$  — marginal product of labour;  $L$  — quantity of labour;  $Y$  — income.

U — share of capital in national income. It is determined by the formula

$$U = \frac{F_K K}{Y}$$

$F_K$  — marginal product of capital; K — mass of capital.

The share of savings in total capital is directly proportional to the mass of labour product and is inversely proportional to one minus the share of the product of capital in the national income [13, Mead J.].

Profit/savings make oscillatory movements. Profit / savings depend on the marginal productivity of labour and the marginal productivity of capital. If the marginal productivity of capital grows, it runs into an obstacle and turns back, causing fluctuating movements in profit (savings).

If the rate of capital accumulation becomes stable, the national income grows at a rate equal to  $(QI + r) / (1-U)$ . This growth of national income remains constant over time. The higher the income level, the greater the propensity to save [14, Pesenti A. pp. 835–836].

D.M. Keynes saw investment as the main impetus for economic growth. This can be written down as follows:

$$\frac{\Delta Y / \Delta I}{Y} = \frac{\Delta Y}{Y} \cdot \frac{Y-C}{\Delta Y - \Delta C} = \frac{1 - \frac{C}{Y}}{1 - \frac{dC}{dY}}, \text{ where (14)}$$

$\Delta$  — growth; Y — national income; I — investments; C — consumption.

Economic growth increases or decreases depending on how consumption increases or decreases: in a greater or lesser proportion than income [15, Keynes J.M., p. 193].

L. Balcerowicz and A. Zhonca believe that the main impetus for economic growth is the country's institutional system. Institutions are understood as all non-material and relatively stable factors that are external to a person and are able to influence his or her behaviour. A distinction is made between institutions that are responsible for economic vulnerability and resilience, and those that create a concentration of systemic development forces. The main acceleration institutions are property rights, the level of property protection, the degree of competition between producers, and the fiscal policy of states.

Economic growth occurs on the basis of innovation, but institutions can restrain or, conversely, accelerate economic growth [16, Balcerowicz L., Zhonca A., p. 56–61].

J.Yu. Stiglitz focuses on income distribution when analyzing the relationship between push and spread of economic growth. A simple redistribution of income from the rich to the poor can increase the wealth of a society, since the rich may lose less utility than the poor gain. The sum of utilities from redistribution may increase [17, Stiglitz J. Yu., P. 100].

### ***Overview of publications on investing in agriculture in the Far North***

E.V. Kudryashova, L.A. Zarubina, I.A. Sivobrova draw attention to the need to form bioeconomy and bioindustry in the Arctic zone [18].

The state authorities of the Komi Republic are actively helping the region's investment development in agriculture. According to the Resolution of the Government of the Komi Republic dated October 31, 2019 No. 525 "On the State Program of the Komi Republic "Development of Agriculture and Regulation of Agricultural Products, Raw Materials and Food Markets, Development of the Fishery Complex of the Komi Republic", the volume of investment in fixed capital in agriculture of the Komi Republic is expected to increase by 36.5% by 2025 <sup>2</sup>.

In 2019, the degree of depreciation of fixed assets in crop and livestock production in the Komi Republic amounted to 40.2%, the share of fully depreciated fixed assets of commercial organizations (excluding small businesses) in the region's agriculture was 9.4%, the renewal rate — 7.0% <sup>3</sup>.

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V.A. Ivanov, V.V. Terentyev, I.S. Maltseva consider it necessary to constantly modernize the fixed assets of producers of agricultural products, raw materials and foodstuffs in the Komi Republic. The authors believe that it is necessary to increase the renovation rate of fixed production assets; in particular, it is important to introduce from 600 to 100 cattle-breeding facilities annually [19].

A.S. Ponomareva considers it necessary to increase the state's contribution to financing innovative activities in the agro-industrial complex of the Komi Republic, in particular, to compensate for the losses of agricultural producers due to rising prices for gasoline, diesel fuel, electricity, gas, mineral fertilizers, machinery, seeds, and concentrated feed [20].

A. Nikitin believes that the development of agriculture in the Far North and the Arctic will continue on the basis of experimental technologies (greenhouse farming, hydroponics). This will require a lot of investments. These investments are justified if the country wants to bring people back to the Arctic and regions of the Far North <sup>5</sup>.

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<sup>2</sup> Postanovlenie pravitel'stva respubliky Komi ot 31 oktyabrya 2019 g. № 525 «O gosudarstvennoy programme Respubliki Komi «Razvitie sel'skogo khozyaystva i regulirovaniya rynkov sel'skokhozyaystvennoy produkcii, syr'ya i proizvod'stviya, razvitie rybokhozyaystvennogo kompleksa Respubliki Komi» [Decree of the Government of the Komi Republic dated October 31, 2019 No. 525 "On the state program of the Komi Republic "Development of agriculture and regulation of agricultural products, raw materials and food markets, development of the fishery complex of the Komi Republic"]].

<sup>3</sup> Doklad «Sotsial'no-ekonomicheskoe razvitie Respubliki Komi v 2019 g.». Syktyvkar, Ministerstvo ekonomiki Respubliki Komi. 2020. S. 45 (77 s.) [Report "Socio-economic development of the Komi Republic in 2019". Syktyvkar, Ministry of Economy of the Komi Republic. 2020. S. 45 (77 p.)].

<sup>4</sup> V Komi v 2019 godu ob'em investitsiy v osnovnyy kapital sel'skogo khozyaystva sostavil 135%. 28 avgusta 2020 g. [In Komi in 2019, the volume of investments in the fixed capital of agriculture amounted to 135%. August 28, 2020]. URL: <https://kominform.ru/news/202852> (accessed 01 March 2021).

<sup>5</sup> Nikitin A. Zona surovogo zemledeliya [Zone of harsh agriculture]. Parlamentskaya gazeta [Parliamentary newspaper]. URL: <https://www.pnp.ru/social/zona-surovogo-zemledeliya-html> (accessed 01 March 2021).

N.V. Voroshilov considers it necessary to develop various forms of cooperation of agricultural producers in the implementation of investment activities [21, Voroshilov N.V.].

However, we should state that there is no consensus on the advisability of developing investment activities in the agricultural sector of the Arctic and the Far North.

In Alaska, 95% of food is imported from abroad and from other parts of the United States. The average growing season has increased by 45% over the past 100 years. It takes 60 hours to deliver fresh produce from California to Anchorage. The delivery of fresh produce from Anchorage to remote settlements in Alaska takes another 7 days. In Alaska, agriculture itself takes place, with enthusiastic single farmers developing agriculture. The number of farms increased by 62% from 2007 to 2014. These farms sell products directly to consumers. As of 2014, the USDA has subsidized the construction of greenhouses in the amount of \$4 million. However, the issue of investment in Alaska agriculture remains controversial <sup>6</sup>.

We have not found any researchers explicitly disagreeing with investment in Arctic and Far North agriculture. But indirectly, the existence of such an opinion and its strength is evidenced by the following fact: on April 15, 2009, the Office of the Federal Antimonopoly Service in the Komi Republic (Komi OFAS of Russia) found the republican Ministry of Agriculture and Food to be in violation of the Law "On Protection of Competition". Eighteen antitrust cases were initiated. It was claimed that in 2007–2008, the Ministry provided state assistance in the form of budget subsidies to the regional agricultural enterprises without the consent of the antimonopoly body. This is a violation of Article 20 of the Law "On Protection of Competition" dated July 26, 2006 No. 135-FZ. Assistance was provided for 18 types of subsidies. Separate proceedings were initiated by the Komi Administration of the Federal Antimonopoly Service for each failure to agree with the Komi Administration <sup>7</sup>.

The decision of the Office of the Federal Antimonopoly Service for the Komi Republic dated April 15, 2009, was invalidated by the Arbitration Court of the Komi Republic <sup>8</sup>.

N.V. Rodnina shows that the traditional branches of the agro-industrial complex of Yakutia do not show investment activity [22].

### **Research materials**

The analysis performed to determine the multiplier effect in agriculture in the Komi Republic for 2010–2018, calculated on the basis of formula (1), shows that in some years the multiplier coefficients are unstable, they range from -0.6 to 0.4. This indicates unstable (unsustainable) fi-

<sup>6</sup> Vopreki klimatu. Alyaska aktivno razvivaet sel'skoe khozyaystvo 30.09.2017 [Against the climate Alaska is actively developing agriculture 09/30/2017]. URL: <https://propozitsya.com/vopreki-klimatu-alaska-aktivno-selmskoye-hozyaystvo> (accessed 01 March 2021).

<sup>7</sup> Minsel'khozprod Respubliki Komi priznan vinovnym v narushenii antimonopol'nogo zakonodatel'stva. 15.04.2009. [The Ministry of Agriculture and Food of the Republic of Komi was found guilty of violating the antimonopoly law. 04/15/2009]. URL: <https://komi.fas.gov.ru/news/7206.28.02.2021> (accessed 01 March 2021).

<sup>8</sup> Reshenie Arbitrazhnogo suda Respubliki Komi ot 02.03.2010 po delu № A29-3700/2009 [Decision of the Arbitration Court of the Republic of Komi dated March 2, 2010 in case No. A29-3700/2009]. URL: <https://zakon-region3.ru/39247/> (accessed 28 February 2021).



ancing of investments in agriculture in the region. Over the specified period, with a significant variation in investments in fixed assets (from -37.7 to +68.7%), the production of agricultural products in some years fluctuated from minus to plus, fluctuations occurred in the range from 2.4 to 28.0% (Table 1). It should be noted that the positive index of production is to a greater extent associated not with an increase in the physical volume of production, but with an increase in value due to an increase in prices.

The investment effect multiplier can be determined by the formula

$$M = \frac{\Delta \text{Выпуск}_{c/x}}{\Delta \text{Инвестиции}_{c/x}} \quad (15)$$

Where M — multiplier,

$\Delta \text{Выпуск}_{c/x}$  — output dynamics in comparison with the previous year;

$\Delta \text{Инвестиции}_{c/x}$  — investment dynamics in comparison with the previous year.

Indicators of the investment effect multiplier by type of activity “Agriculture and provision of services in this area” in the Komi Republic for 2010–2018 are reflected in table 1.

Table 1

*Dynamics of production and investments by type of activity “Agriculture and provision of services in this area” in the Komi Republic for 2010–2018<sup>9</sup>, % to the previous year*

Indicator / years	2010	2011	2012	2013	2014	2015	2016	2017	2018
Investments in fixed assets of the sector “agriculture and the provision of services in this area” in % to the previous year	68.7	23.2	93.1	37.7	52.1	24.4	29.5	22.2	32.2
Agricultural output in % to the previous year	28.0	90.0	18.1	14.5	24.4	24.2	84.1	13.3	33.2

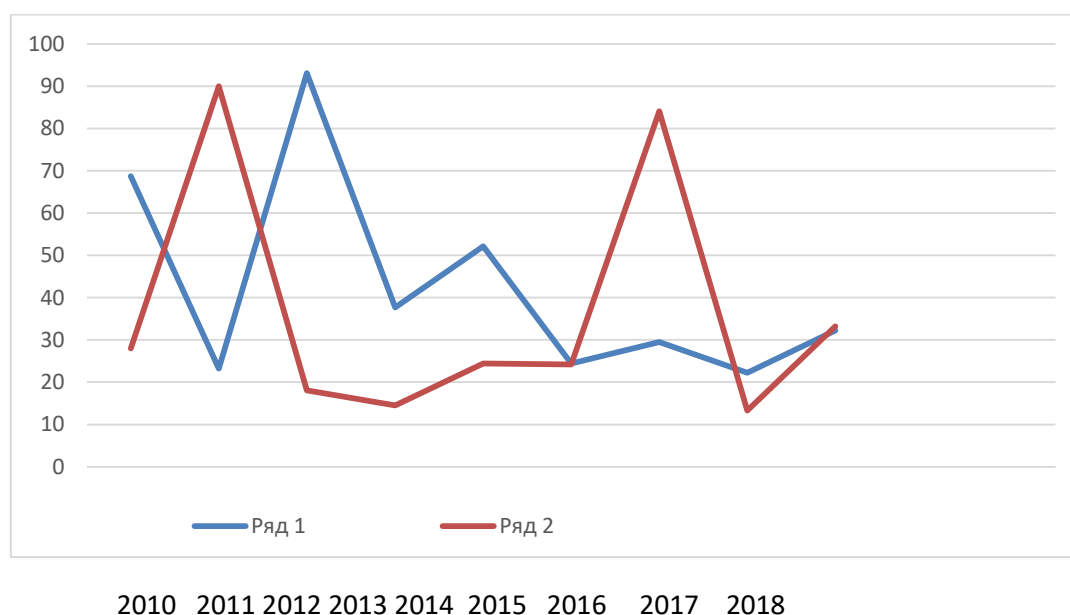


Fig. 1. Row 1 — Investments in fixed assets of the sector “agriculture and the provision of services in this area”, in % to the previous year; Row 2 — Agricultural production in % to the previous year.

<sup>9</sup> Authors' calculations according to the data of the State Statistics Committee of the Republic of Komi.

As shown in table 1, the dynamics of agriculture in the Republic of Komi in 2010–2018 was unstable. In 2010, the agricultural production index in relation to 2009 was 28%, in 2016, compared to 2015, — 84.1%. Investments in 2010, compared to 2009, increased by 68.7%, and in 2012 — by 93.1%.

Dynamics of the investment effect for 2010–2018 in the Komi Republic is shown in table 2.

Table 2

*Dynamics of the investment effect for 2010–2018 in the Komi Republic*

Indicator / years	2010	2011	2012	2013	2014	2015	2016	2017	2018
Multiplier, units (agricultural output / investments in fixed capital)	0.4	0.38	0.19	0.38	0.46	0.99	2.85	0.59	1.03

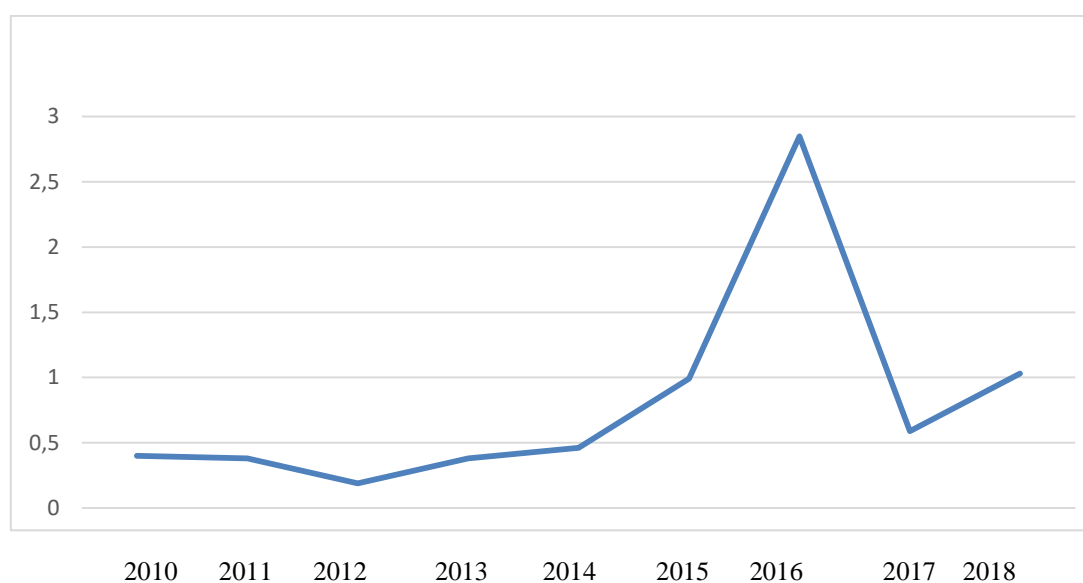


Fig. 2.

The effect of investments in agriculture and services in this area ranged from 0.4 in 2010 to 2.85 units in 2016. The dispersion of agricultural products for the period 2015–2018 amounted to 848.1. The variance of the multiplier was 1.526. The dispersion in the dynamics of investments was even greater — 1771.1.

The correlation coefficient between the dynamics of output and investment in fixed assets in agriculture for 2010–2018 amounted to 0.117, i.e. it is very low.

The sum of percentage growth for 2010–2018 of agricultural output accounted for 301.8%, the amount of investment growth percent was 214.5%. The total investment multiple was 1.4.

The unsustainable dynamics of investments in the agrarian complex and the output of agricultural products require managing the multiplier effect from investments. The task of balancing the investment cycle — ensuring the normative proportionality of investments in fixed assets and obtaining a corresponding income in subsequent years. It is important to use modern and high-tech management technologies, such as project management, program management, risk management, and the application of key indicators.

It should be emphasised that investment is just a prerequisite for production growth. Today, most of the technologies introduced into production in the agro-industrial potential of the region are industrial technologies, weakly affected by digitalization; investments are accompanied by only minor modifications of previous technologies. At the same time, insufficient attention to improving the quality of land and raising the professional level of workers also does not contribute to an increase in the multiplier effect of investments. The poor state of land and labour resources leads to a decrease in the return on investment resources used.

However, there are examples of successful implementation of investment projects in the agricultural sector of the Komi Republic. These include investment in the development of greenhouse facilities in Sosnogorsk. Direct investments in the greenhouse complex in the city of Sosnogorsk were initially assumed to amount to 3.2 billion rubles. Construction began at the end of 2017. The complex was put into operation in the fourth quarter of 2018. 5th generation greenhouses were built. The complex is specialized in growing vegetables; deep automation of plant growing processes has been developed. Test sowing was carried out on March 28, 2019. The assets of the "Sosnogorsk" Greenhouse complex as of 31.12.2019 amounted to 4.068 million rubles, revenue for 2019 — 68 million rubles. Net assets as of 31.12.2019 amounted to 83.4 million rubles, net profit for 2019 — 170 thousand rubles. The average number of employees in 2019 was 54 people. The long-term goal is to achieve production of 10 thousand tonnes of vegetables per year<sup>10</sup>.

### *Integral efficiency index*

We propose to introduce the integral efficiency index. It is based on the assumption that the investment multiplier depends on return on assets, land productivity, and labour productivity.

The general view of the integral efficiency index in the presence of N initial indices will take the following form:

$$JIЭ = (И_{\Phi O} + И_{3O} + И_{ПТ}) / 3, \text{ where: (16)}$$

И<sub>ΦO</sub> — change in capital productivity (ratio of gross output and used fixed assets);

И<sub>3O</sub> — change in the ratio of gross output to investments in land improving;

И<sub>ПТ</sub> — change in the ratio of gross output to the wages fund of employed workers.

Labour productivity growth results in lower wage intensity of production, which compensates for the decrease in capital and land productivity and, ultimately, provides a multiplier effect of investment. This effect is fully compensated if weights of capital productivity and land productivity indices are equal.

We transform formula (16) into the formula

$$KIЭ = (K_{\Phi O} + K_{3O} + K_{ПТ}) / 3, \text{ where: (17)}$$

<sup>10</sup> Finansovoe sostoyanie OOO «Teplichnyy kompleks «Sosnogorskiy» [Financial condition of Sosnogorsky Greenhouse Complex LLC]. URL: [https://www.test/firm.ru/result/1108023823\\_ooo-teplichnyy-kompleks-sosnogorskiy](https://www.test/firm.ru/result/1108023823_ooo-teplichnyy-kompleks-sosnogorskiy) (accessed 23 March 21).

ККиэ — combined integral efficiency coefficient of investment defined in terms of asset productivity, land productivity, and labour efficiency;

Кфо — capital productivity (ratio of output and fixed assets);

Кзо — ratio of output to land area;

Кпт — ratio of gross output to number of employees (labour productivity).

We have established the following value of the combined coefficient of integral investment efficiency in the Komi Republic for 2010–2018.

$$Иэ = (0.901+0.842+1.504) / 3 = 1.082$$

$$ККиэ = 0.901+0.842+1.504=1.082$$

The closeness of ККиэ to unity shows that the growth of labour productivity as a result of investment almost completely compensates for the decrease in asset and land productivity.

During the years of economic reforms since 1991, the number of workers in the agricultural and services sectors in the Komi Republic has decreased by almost 10 times. However, positive shifts are still observed in a small range of individual large enterprises.

In order to increase the efficiency and competitiveness of the regional agro-industrial complex, individual investment projects should be integrated into investment clusters with full-fledged technical and technological complexes corresponding to modern agro- and biotechnologies. It is necessary to transform the structural composition of the fixed capital of economic entities towards digitalization and an increase in the share of mental labour, respectively, to increase human capital of the agro-industrial complex of the Komi Republic [23, Mustafaev A.A.].

E.V. Chaplygina and S.N. Mikhaylov believe that in the practice of managing agricultural enterprises it is necessary to use a wide range of methods for assessing competitiveness, taking into account the marketing environment of the regional food market [24, Chaplygina E.V., Mikhaylov S.N., p. 23].

The level of acuteness of competition depends on the availability of production and social infrastructure facilities, the use of effective methods of management, therefore, the development of investment strategy for economic entities should begin with the analysis of the competitive environment and identification of free market niches. At the same time, it is important to carry out predictive calculations of changes in natural and climatic conditions.

It should be noted that the agro-industrial complex sectors are characterized by low investment attractiveness. However, long-term investment in agricultural enterprises is necessary due to the need to ensure food security and sustainability of the region's food market.

For the period 2010–2018, fluctuations in the growth of investments in fixed assets between individual types of agricultural activities ranged from 1.5 to 15 times (according to our estimates). Thus, a retrospective analysis shows a significant volatility of investment in agricultural enterprises. This leads to the conclusion that there is no scientific basis for the investment needs of the economic entities in the agro-industrial complex of the region. This is a gap in the investment strategy of the region, and it needs to be filled.

There is a periodic revaluation of operating production assets in the agricultural enterprises of the region. We believe that this practice of revaluing fixed assets causes artificial price increases.

The revaluation of exploited assets means an increase in the statutory fund of enterprises. However, the regular revaluation of fixed assets complicates the calculation of depreciation deductions for enterprises, thereby making it difficult to generate investment resources and increase the effect of investments.

For example, the physical volume of used machinery and equipment decreased in the Republic of Komi in 2010–2018. It was 23.8% for tractors of all brands, 27.4% for tractor trailers, 24.4% for ploughs, 41.6% for sowing machines, 50.1% for cultivators, 10 and 60% for solid and liquid organic fertilizers, respectively. The number of grain and potato harvesters was reduced by 2.4 times, spreaders of solid mineral fertilizers — by 60.5%, sprayers and dusters — by 77%. Over the years, the energy capacity in the agricultural sectors of the republic has decreased from 302.1 to 266.3 thousand hp or 13% (authors' estimations). The decrease in the physical volume of the used machinery and equipment is explained by such factors as increased competition among suppliers in the food market, decline in agricultural output in the region, and drop in investment activity. Under these conditions, although the investment effect remains positive, it is unstable.

The condition and movement of livestock in agricultural organizations of the republic should be considered unsatisfactory. For 2010–2018, apart from reindeer breeding, a decrease in the number of all types of animals is observed: horses — 1.7 times, sheep — 10.3 times, birds — 1.4 times, and pigs — by 10%. A decrease in the number of livestock was also observed in households during this period. The number of cattle decreased by 1.5 times, including cows — by 1.6 times, pigs — by 2.1 times, sheep — by 1.3 times, goats — by 1.2 times, horses — by 1.3 times. The number of birds has noticeably increased (1.3 times), the number of bee colonies has increased from 252 to 375 units, or almost 1.5 times (authors' estimations).

If we pay attention to the gross harvest of crop products, we can see that all types of agricultural products do not have a stable dynamics of development, and in general, the area for sowing is decreasing. Hence, the conclusion is that investment in agriculture in the Komi Republic has so far been accompanied by a noticeable multiplier effect, but it is not sufficient to ensure the competitiveness of agricultural enterprises in the regional market of agricultural and food products.

The way out of this situation is, in particular, as follows: the capital resources of the agro-industrial complex should be assessed not by the cost of their acquisition and use, but based on the assessment of "income-generating" factors, such as access to external regional markets, new types of raw materials processing, new types of cultivated plants, including medicinal ones [24, Chaplygina E.V., Mikhaylov S.N., p. 88].

It should be noted that in terms of production activities, resource turnover and the current system of pricing, taxation, and debt repayment, the agricultural sector of the region's economy

differs significantly from other sectors. This makes it impossible to use in the agricultural sector such a system of pre-calculation, which is used in industry. The system of preliminary calculations of the investment multiplier effect does not give an opportunity to assess the sustainability of the multiplier effect of the agro-industrial complex.

### *Conclusions and recommendations*

1. The new image of the economic life of the agro-industrial complex of the region requires the resumption of an active regime of investment and innovation activities, a transition to expanded reproduction;

2. It is important to consolidate the basic financial and economic principles of investment in legislative acts, differentiated by industries (focus on meeting the needs of the market and the population, efficiency, balance, unity of interests of society, enterprises, workers, development of efficiency standards by branches) [25, Mustafaev A.A., p. 477];

3. Dynamic production growth is possible only on the basis of an increase in investment activity. It occurs in three aspects: intellectualization of production, motivation for investment, compliance with environmental needs;

4. Reduction of inflation “to zero”, increase in the amount of collected taxes, nominal increase in production volumes obscures the real problem: how to ensure sustainable growth of real sectors of the agro-industrial complex of the Komi Republic;

5. Ensuring a high multiplier effect of investments is an important area of regulation of the investment cycle in the agrarian-industrial complex of the Komi Republic;

6. It is advisable to formulate the category of economic responsibility of business entities and state regulation bodies of investment activity in the agro-industrial complex for the state of the investment cycle [26, Begzhanov B.N.]. The economic responsibility of business entities and regulatory bodies in the investment sphere refers to organizational, financial and tax measures to increase the stability of the investment sphere in the agro-industrial complex of the Komi Republic.

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