Scientific and technical development of regional agriculture: methodological aspects of analysis and forecasting

L Adadimova\textsuperscript{1*}, T Oydup\textsuperscript{2} and Yu Polulyakh\textsuperscript{1}

\textsuperscript{1} Volga Research Institute of Economics and the Organization of Agro-Industrial Complex, 12 Shehurdin str., Saratov 410010 Russia
\textsuperscript{2} Tuvinian Institute for Exploration of Natural Resources of Siberian Branch of the Russian Academy of Science, 117A Internatsionalnaya str., Kyzyl 667007 Russia

E-mail: adadimova@inbox.ru

\textbf{Abstract.} The paper shows that the main sign of the difference between scientific and technological development (STD) and progress (STP) is the degree of impact on the industry in which they occur, which is defined by the keywords “development” and “progress”. In the first case, it is assumed that a transition from one state to another is indispensable, and it is only possible in the second one. Until recently, there is a lack of statistical information on “science and innovation activity” for agriculture as an independent industry. It is emphasized that to assess the level of agricultural development, first of all, it is necessary to apply economic indicators and criteria. Some researchers suggest using the “golden rule” for this purpose, which characterizes the development of the industry or organization. A proprietary version of this criterion is proposed. The completed study shows that the current problem of the pension system arose due to the authors ignoring its development of the scientific and technological progress in the country, as a result of which the living labor is being supplanted, wages are relatively reduced, and the ratio between pensioners and working citizens increases. Since the Pension Fund is formed at the expense of insurance premiums from accrued wages (fund of a payment, or FPW), the possibility of retirement benefits is quite naturally narrowed. The source of financing of the pension system should be a non-reducing wage (labor cost), and its result is the increasing value added.

1. Introduction
The relevance of research in the field of scientific and technological development of agriculture is explained, first of all, by the recent adoption of a number of important documents at the federal level. In particular, this is the instruction of the President of the Russian Federation in June 2015 and then his Decree “On the Strategy of the Scientific and Technological Development of Russia”, as well as the “Forecast of the Scientific and Technological Development of the Agro-Industrial Complex of the Russian Federation for the Period until 2030”. Experts of the Center for Strategic Research stated the need for a technological revolution in Russia. At the same time, two documents seem to be very contrasting, namely the “Forecast of the Scientific and Technological Development of the Agro-Industrial Complex of the Russian Federation until 2030” and “Federal Scientific and Technical Program for the Development of Agriculture for 2017-2015”. The first of them is expected to develop breakthrough technologies, high-tech innovative products, including the use of artificial intelligence; and in the second, it is planned only to increase the use of seeds of new domestic varieties, pedigree
products (material), production of high-quality feed, feed additives for animals, medicines for veterinary use, production of pesticides and agrochemicals of biological origin, technologies for processing and storing agricultural products, increasing the number of quality methods of production control of agricultural products, raw materials and food. But all this is characterized as an increase in the use of certain factors, although it is implied as a result of qualitative changes, should occur in agriculture. This fact makes it imperative to analyze the legitimacy of using the same key word “development” in both documents, as well as to consider other aspects of these processes in the agrarian sector of the economy.

2. Methods
General scientific methods of economic research (monographic, abstract logical, system analysis and synthesis, etc.) were used.

3. Results
The scientific and technical development, if we bear in mind that this rather new term corresponds, in fact, to its predecessor, the “scientific and technical progress” (STD), but it differs from it in that its key word “development” implies a process of natural change, transition from one state to another, more perfect, transition from the old qualitative state to the new one, from simple to complex, from lower to higher” [1, p. 943]. Whereas the “progress” means moving forward, from the lowest to the highest, changing for the better; development of new, advanced [1, p. 914]. Apparently, in the current situation, i.e. in relation to the Federal Scientific and Technical Program for the Development of Agriculture, it is better to use the old term (“scientific and technical progress”) as “progressive, interconnected, and interdependent development of science and technology” (which is quite true), due to the objective requirements of material production and society in on the whole, by the growth and complication of human needs” [1, p. 914], which is also true. Thus, the difference between the terms STP and STD mainly consists in the fact that “progress” is, to a greater extent, the growth at a certain pace (in a certain “progression”), although it implies development, while “development” means qualitative changes and transition from one state to another. Consequently, scientific and technological development should involve certain stages.

In addition, it is necessary to consider different perspectives of both STP and STD. Regardless of any industry, they are only a characteristic of the scientific and technical infrastructure, and they can be complete and characterize changes in the industry itself only in relation to a specific production. Therefore, on the one hand, we should talk about the creation of innovations, i.e. directly about science and technology development, as an environment, infrastructure, tools, including their birth in the production process. On the other hand, it is necessary to analyze innovations that are introduced directly into production and society, where they are embodied, demonstrate economic efficiency and social consequences. According to V. I. Lenin, increasing labor productivity is the main condition for the transition to a new technological order. But, if a STP, for example in agriculture, has a necessary and sufficient criterion, such as the growth of labor productivity and ensuring an increase in the profitability of production, then it is only a necessary condition for STD. For the final conclusion on the availability of scientific and technological development (as a sufficient condition), it is necessary to fix the abrupt growth of labor productivity and structural changes in the value of the product, changes in the value structure of production.

Accordingly, in the study of these terms, it is necessary to apply different economic theories. The theory of a “big push” is more applicable to scientific and technical progress in modern agriculture, when “in order to get out of stagnation, a large infusion of capital is needed, which results in self-sustaining growth ... The amount of investment should be sufficient to start the irreversible movement ...” [1]. Science and technology development is more applicable to the theory of “stages of economic growth”, implying a transition from a traditional to an informational society in six stages: a traditional
society, the creation of prerequisites for takeoff, maturity, high mass consumption, search ing for a quality of life (which is the creation of an information society). In this case, the following criteria are used: the level of development of technology, the sectoral structure of the economy, the share of production accumulation in national income, the structure of consumption, etc. [2]. Scientific and technical progress in agriculture is more inherent in intensification and resource conservation, and in scientific and technological development, the introduction of high-performance means of production and fundamentally new technologies that displace living labor.

In the statistics of innovation activity in the Russian Federation, “science”, as the main source of innovation, in 2016 was characterized by the following indicators: the number of personnel engaged in research and development in the whole country was 722.3 thousand, of which 370.4 thousand were researchers, or 51.3%; domestic expenditures on research and development were 943.8 billion rubles, of which 356.7 billion rubles were for economic purposes (or 37.8%), including 19.8 billion rubles in the field of agriculture, hunting and forestry (or 5.6%). More numbers from 2016: internal current expenses for research and development in the whole “science” amounted to 873.8 billion rubles, of which 15.2% was directed to basic research, 20.7% to applied research, and 560.4 billion to development or 64.1%. Of the total amount of agricultural science, only 13.9 billion rubles were allocated. (1.59%), of them for fundamental research 8.1 billion rubles, or more than 58%, for applied 4.0 billion rubles. (28.8%), and only 1.8 billion rubles for development (12.9%), which from the total amount of development costs amounted to only 0.3%. In addition, without isolating agriculture, the following information is available. In 2016, more than 1.5 thousand advanced production technologies were developed, which is 2.12 developments per 1,000 people with costs of 615.2 million rubles on 1 technology.

Information on science and innovations in the subjects of the Russian Federation in the relevant section of the Russian Statistical Yearbook (23: science and innovations) is presented only in one table, but it allows you to get some estimates of the links between individual indicators. In particular, Table 1 shows the results of the correlation analysis performed by the authors. As can be seen, the main factors (independent variables), the number of personnel (X1) and internal costs (X2) correlate very strongly among themselves (the correlation coefficient is 0.996) and with the most important (primary) result, which is the number of developed advanced production technologies (Y1) with one the same closeness of communication (0.835). The influence of factors on the main secondary result - the number of advanced production technologies (Y2) used is somewhat weaker, but it is still fairly moderate. The connection of the primary result of scientific research (Y1) with the secondary result (Y2) is slightly higher (0.794) than the connection of factors with it (0.766 and 0.758). At the same time, the influence of science (X1, X2, and Y1) on the innovative activity of organizations is extremely weak, almost insignificant.

For scientific and technical progress in the agriculture of the region, for its actual implementation, innovation activity is of great importance, defined in the expert and analytical report of the CSR, as “the proportion of organizations implementing innovations of individual types in the total number of organizations surveyed” [3]. Unfortunately, first, this is far from a complete definition, and, second, as many researchers note, the “system of accounting and evaluation of innovations in agriculture in modern Russia” is not perfect [4-6]. These authors indicate that agriculture, as an industry, was not allocated to a separate section of official statistics and did not have (until 2017) methodological tools. They developed their own guidelines for improving accounting and evaluation of innovations in agriculture.
Table 1. The correlation analysis of the state of science and innovation activity in the Russian Federation in 2016 (correlation coefficients).

| Indicators                                      | Variables       | X_1  | X_2  | Y_1  | Y_2  | Y_3  | Y_4  |
|------------------------------------------------|-----------------|------|------|------|------|------|------|
| Number of personnel engaged in research and development | X_1             | 1,000| 0,996| 0,835| 0,766| 0,275| 0,284|
| Domestic research and development costs         | X_2             | 0,996| 1,000| 0,835| 0,758| 0,272| 0,284|
| Number of advanced technologies developed      | Y_1             | 0,835| 0,835| 1,000| 0,794| 0,287| 0,278|
| Number of advanced technologies used           | Y_2             | 0,766| 0,758| 0,794| 1,000| 0,485| 0,361|
| Share of innovative products, works, services in the total volume of goods shipped | Y_3             | 0,275| 0,272| 0,287| 0,485| 1,000| 0,446|
| Share of innovation organizations in the total number of organizations | Y_4             | 0,284| 0,284| 0,278| 0,361| 0,446| 1,000|

Another equally important criterion of scientific and technological development is the volume of innovative products produced or produced using innovative technologies, i.e. as a result of innovative and investment activities. In turn, innovative activity, as some researchers suggest, can be characterized with the help of such categories as innovative ability (orientation), innovative potential and innovative activity [7, p. 47]. Tatyana Petrova-Shatokhina analyzed a systematized set of existing definitions of the term “innovation potential” and suggested considering it relatively socio-economic system as its ability to realize an innovative development model “with the goal of transition to a qualitatively new state based on the use of innovative developments ensuring the formation of sustainable competitive advantages and obtaining systemically significant effects (economic, social, environmental, etc.)” [7, p. 29]. At the same time, feeling some incompleteness of the definition associated with the need to attract investment resources to the process of innovation development, the author suggests using the term “innovation-investment potential of the system development”, suggesting to mean “the system’s ability to modernize and transition to a new qualitative state taking into account investment attractiveness of the system as a whole and its individual elements and to adequate financial support for innovation” [7, p. 29-30].

N. E. Ryzhenkova [8] devoted her work to the substantiation and development of methodological approaches to the formation of an assessment of innovation and investment attractiveness of enterprises. She identifies a total of two types of innovation potentials (project and actual) and two types of innovation and investment attractiveness of an enterprise, believing that they should reflect the content of the innovation process in the framework of expanded reproduction. The best option for the development of the organization, according to N. E. Ryzhenkova, is ensured if the “golden rule of an enterprise” is fulfilled, when profit growth (as a percentage) outpaces revenue growth from sales of
products, which, in turn, outpaces the growth in the value of fixed and current assets, which should exceed 100%. In addition, it is proposed to apply a sustainability coefficient of economic growth, equal to the ratio of the accumulation fund to the average annual equity capital.

Further, this rather simple formula unfolds into a deterministic four-factor model, which is the product of four factors/relations (coefficients): the share of the accumulation fund in net profit, the share of net profit in revenue, the ratio of revenue to assets of an organization, the ratio of assets to equity. N. E. Ryzhenkova believes that on the basis of this formula, it is possible to predict the development of the organization. The desired attractiveness is estimated by the complex indicator “enterprise attractiveness ratio” (EAR), defined as the sum of the works of class criterion indicators for their significance.

4. Discussion

It should be noted that a rigorous calculation of the complex indicator of innovation-investment attractiveness is unlikely to significantly enrich the estimated tools, while the sustainability of the economic growth (Kur) is of certain interest. As for the “golden rule of an enterprise,” it should be given a slightly different interpretation. A.A. Chernyaev, I.V. Sharikova and other coauthors [9] use the term “golden rule of economics” as opposed to “enterprise”, and they use the “growth rate of capital or balance currency” instead of the “growth in the value of fixed and current assets”. It is worth recalling that the primary is simply the “golden rule” characteristic of mathematics, and it is based on the “golden section” when a straight line segment is divided into two unequal parts so that the ratio of the smaller part to the larger is equal to the ratio of the larger part to the length total segment. This ratio is 0.618. In Economics, it can be used in finding a rational relationship between constant and variable parts of the cost of production in order to develop the constants “C” and “V.” Apparently, it is possible to apply when assessing the division of assets into non-current and current assets of funds into main and current, etc. In this case, the “golden rule” of an enterprise or economy can be somewhat transformed on the basis of our previous developments [10, 11, 13] and entered into the process of expanded reproduction. It is necessary to start with the growth of the value of fixed and current assets and put it in the reverse order: the growth of the value of fixed and working capital (Kmai ob cpt), due, inter alia, to external sources, should provide a higher increase in production or production costs (Kpr), which is due to the stability or restrained growth of its domestic consumption, causes a higher revenue growth (Kwt), and this revenue growth (based on the marginal effect) provides a higher growth in gross profit (Kpr); the latter, in turn, gives a new impetus to the expansion of production (in its new cycle), that is, at a new turn in the spiral of the enterprise life cycle. This rule can be written as follows (1).

$$1,0 < K_{mai \text{ ob cpt}} < K_{Qt} < K_{wt} < K_{pr} \rightarrow K_{mai \text{ ob cpt}(t+1)} \geq K_{mai \text{ ob cpt}} \quad (1)$$

It follows from this rule: if the growth rate of fixed and circulating assets in the new cycle of reproduction (Kmai ob cpt(t+1)) is equal to the similar coefficient of the previous cycle (Kmai ob cpt), then there is an extended reproduction at a given rate (excluding inflation). If Kmai ob cpt(t+1) is more than Kmai ob cpt, then the rate of expanded reproduction is accelerated. Then the process repeats. Table 2 clearly shows (with a few exceptions) the development of agricultural organizations in the Saratov region in the period from 2008 to 2016.

First of all, the main rule is observed: an increase in labor productivity due to the improvement of the means of production and a reduction in the cost of living labor. As can be seen, an increase in the cost of fixed and working capital in 2016 is 1.77 times in comparison with 2012 and 2.48 times in comparison with 2008 allowed reducing the number of employees compared with 2012 by 7.5%; and it is 32.8% since 2008. This led to a significant increase in economic efficiency and labor productivity, the added value of products in the total mass increased by 2.69 times in comparison to 2012, and it was 3.46 times since 2008. Calculated per 1 employee, the indicators are much higher: 2.91 and 5.15 times. The “golden rule” was also largely respected. In relation to 2008, i.e. for 8 years, fixed assets
and working capital increased 2.48 times, revenue from sales of products were 3.02 times, and the gross profit was 4.8 times. This made it possible to increase the financing of investments by 3.1 times at the expense of profits, by 3.38 times at the expense of own sources, and by 2.85 times in the total amount. Naturally, this made it possible in the new production cycle (2017) to significantly increase the capital equipment of organizations and the capital-labor ratio. If compared to 2012, the situation is somewhat different, although in general the ratio of key parameters is observed. Simply, the agricultural organizations sent a very small part of the profits to finance investments in 2012. As a result, this indicator increased the most in 2016 (5.76 times), of course, that high growth was detected in all of its own funds and in general by the sum of sources.

Table 2. Evaluation of agricultural organizations of the Saratov region according to the criteria of scientific and technical development.

| Indicators | Years | Growth rates in 2016 in relation to |
|------------|-------|-----------------------------------|
|            | 2008  | 2012    | 2016     | 2012    | 2008    |
| Number of employees, people | 32152 | 23362   | 21611,4  | 0,925   | 0,672   |
| Salary, thousand rubles    | 1870854 | 2109995 | 3264284  | 1,547   | 1,745   |
| Fixed and current assets, thousand rubles | 20774668,0 | 29140083,0 | 51439398,7 | 1,765   | 2,476   |
| Revenue, thousand rubles   | 13718753 | 20250434 | 41408629 | 2,045   | 3,018   |
| Gross profit, thousand rubles | 2404314 | 3385621 | 11531531 | 3,406   | 4,796   |
| Value added, thousand rubles: | 4275168 | 5495616 | 14795815 | 2,692   | 3,461   |
| Total, thousand rubles:    | 132,97 | 235,24  | 684,63   | 2,910   | 5,149   |
| Per 1 employee, thousand rubles. | | | | | |
| Financing investment:      |       |         |         |         |         |
| Own funds, thousand rubles | 2684036 | 2478516 | 9066338 | 3,658   | 3,378   |
| Including profit, thousand rubles | 1556822 | 839147 | 4829868 | 5,756   | 3,102   |
| Funds raised, thousand rubles | 2031091 | 2552130 | 4387140 | 1,719   | 2,160   |
| Total, thousand rubles     | 4715127 | 5030646 | 13453478 | 2,674   | 2,853   |

Note: Authoring using the data of the annual reporting on financial and economic activities of agricultural organizations of the Saratov region for 2008, 2012, and 2016.

It is appropriate to recall the well-known statement of Karl Marx, “If machines are considered solely as a means of cheapening a product, then the limit of their use is determined by the fact that labor, which costs their production, must be less than the labor replaced by their use. However, for capital, this boundary is delineated more narrowly. Since it pays for not applied labor, but the cost of the labor employed, the use of a machine is advisable only within the difference between the cost of the machine and the cost of the labor it replaces” [1, p. 204]. It is well-known that the Soviet political economists decided that in the first case (when labor costs are used), the law of using technology under socialism was formed, and in the second (labor cost) one was under capitalism. In many ways, this caused the low efficiency of the equipment produced in the USSR, which was clearly inferior to foreign. By the way, this is what caused the current pension crisis; that is why, it (the crisis) cannot be left unnoticed in the framework of this study. It is based on the aggravation of the contradictions between scientific and technological development, displacing living labor, and increases the ratio of the number of pensioners and the working population in favor of the former, on the one hand, and an archaic formula of formation of the Pension Fund of the country, which is based on a relatively declining wage workers (in percentage of the payroll, FOT), on the other. The crisis was quite
predictable. The term of its occurrence could be predicted by comparing the directions and rates of movement: the average life expectancy of citizens, the ratio between the number of pensioners and workers, inflation and wages.

Since the pension fund was formed in a transition economy, i.e. at the exit of the country from socialism, it would be possible to accept not wages (directly payment for living labor), which tends to decrease, but value added (the amount of wages and profits), i.e. the cost of living labor. Considering that the ratio of profits to wages (the rate of surplus value) increases in the process of scientific and technical progress, then, despite the reduction in wages, the added value certainly increases, and therefore can meet the growing needs of pensioners. Under conditions of sufficiently high inflation, wages are reduced only relatively. They absolutely (due to indexation) increase, but it happens rather slowly. For example, in the agricultural organizations of the Saratov region in 2016, labor costs increased by 41.9% in comparison with 2012 and by 58.8% since 2008. During the same time, gross profit increased, respectively: 3.41 and 4.8 times, and value added did 2.44 and 3.05 times. If we take into account that the base of deductions, i.e. the size of the financial source in 2016 was 3.52 times more (the value added was 3.52 times higher than labor costs), then the rate of deductions to the Pension Fund could be only 7.4%, not 26% (as of now payroll). It is clear that about any collapse of the Pension Fund would have been out of the question. It would not be necessary to increase the retirement age, especially since it contradicts scientific and technological progress, which needs quite young but competent personnel.

According to Figure 1, it can be seen that the number of employees in 2016 decreased if compared to 2012 and 2008 (by 8.4% and 34.5%), but wages increased as a whole (by 1.55 and 1.75 times) and on average per employee (1.69 and 2.66 times). At the same time, the added value increased more significantly and as a whole (by 2.69 and 3.46 times), including the employee (by 2.94 and 5.28 times). It follows that the growth of labor productivity is ahead of the growth of wages (1.73 and 1.98 times), and the wage fund is the least acceptable base for the formation of a pension fund [14].

![Figure 1](image_url)

**Figure 1.** Dynamics of the main indicators of the development of agricultural production in agricultural enterprises of the Saratov region.

Of course, such a serious output is not enough of this example; one needs to take into account the specificity of agriculture, where the formation of profit participating sufficiently large government financial support, as well as the cumulative effect of inflation, resulting due to stretching of the production cycle, especially in the cultivation of winter crops, as a result of a large lag from the
moment of investment (the costs of past years at lower prices) to the sale of products (already at higher prices). Nevertheless, the obtained pattern is confirmed by more general information: the value added tax (VAT) in 2017 “brought more than 5.1 trillion rubles to the treasury, or 34% of the total federal budget revenues. According to the Ministry of Finance, since 2010, the VAT collection in nominal terms has more than doubled (from 2.5 trillion rubles); and the share in total revenues has increased from 30% to 34% over this period” [12, p. 2]. As one can see, the added value increases at a high, faster than wage rate, and throughout the entire economic complex, which confirms the conclusion (hypothesis) that the cause of the problem of pensions for citizens of the country was ignoring the effects of scientific and technological progress in the economy.

5. Conclusions
The study made it possible to more vividly show the difference between the terms scientific and technological progress and scientific and technological development. Also, the paper argues that in the Federal Scientific and Technical Program for the Development of Agriculture for 2017-2022 (adopted and implemented in 2017) and the corresponding regional subprograms are the tools of scientific and technological progress, rather than development. Moreover, Agrarian Science is still developing insufficiently. The analysis of literary sources indicates the fascination of many authors with the characteristic of scientific and technological development from the point of view of innovative attributes, rather than structural changes in the value of agricultural production and the value structure of agriculture. The results of the study revealed the true cause of the current crisis of the pension system of the country and recommended that as a source of formation of a pension fund, it is not the relatively decreasing labor costs (labor cost) that are used, but the result is the increasing added value. It is necessary to proceed from the fact that the employer pays the employee wages for the work performed, and for a worker’s retirement benefit should transfer part of the financial result from this work to the Pension Fund, i.e. must “share” with the employee, as a representative of one of the most important factors of production, financial results. Raising the retirement age of citizens without changing the source of funding will not fundamentally solve the problem, but it can only postpone it for some time. Removal of the pension burden from wages will contribute to removing illegal wages from the shadows and increasing budget revenues from the personal income tax (PIT).

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