Information asymmetry in genetic farming

G A Efimova and S V Efimova
Saint Petersburg State Agrarian University, 2 A Petersburgskoe Shosse, Pushkin, St. Petersburg, Russian Federation
E-mail: agro@spbgau.ru

Abstract. The paper examines a new rent-genetic direction in the development of earth science and the risks of information asymmetry of its current manifestation in agriculture. Practical results imply approbation of logical and mathematical models for implementation of the rent-genetic approach to regulation of land payments that ensure genetic farming development. The study analyzes, evaluates and provides socio-economic substantiation of rental regulators of genetic farming based on activation of genetic factors through the example of crop farming in Leningrad region. Intensive rental income can be ensured in agriculture only in the context of the redistribution of extensive forms of rental income (differential rent I, resource rent, monopoly rent), which is a fundamental condition for creating a competitive environment and investment development in agriculture.

1. Introduction
The increasing number of disturbed agricultural land in the Russian Federation is a consequence of the impact of information asymmetry on production motives of copyright holders, who promote withdrawal of land from production, which hinders the development of genetic farming and confirms the interdisciplinary nature, scientific and practical significance of the problem under study.

The mechanisms of involving land in the production turnover in the Russian Federation work intermittently. The production workers are faced with the task of not using new lands but preserving the existing ones in production, however, this process is increasingly impeded by market mechanisms that are subject to information asymmetry and cannot be optimized without rent regulators. In these conditions, no highly specialized technological areas can be developed.

1. The features of the development of agriculture in market conditions show that the tendency of land degradation can be decreased through the realization of socio-economic interests related to redistribution of income from land use, which will motivate the rational use of land and eliminate the impact of information asymmetry.

Therefore, the study of economic incentives for development of land cultivation technologies, which include rental income, determines the strategic direction of the development of scientific agriculture at an interdisciplinary level.

Due to fair land payments, the structure of rental income is transformed into technological responsibility to create conditions for investment and environmentally responsible behavior of land users.

Depending on the degree of consistency between the structure of rental income and the system of land payments, which regulate investment demand for land resources, a proportion of factors is formed that generates the structure of the farming system as well.

2. The study of information asymmetry of genetic farming indicates that the rate of change in factor
income and, hence, motivation to increase the ecological and technological responsibility of agribusiness entities can be affected through regulation of the structure of rental income.

Global tightening of competition rules increases the scientific significance of the problem of using rental regulators in the development of investment and innovation activity and makes it strategically important.

Disruptions in the system of movement of rental income in agribusiness unbalance investment and technological interests and information asymmetry in genetic farming.

Unbalance of investment and technological interests that gives rise to factor contradictions in the farming system is caused by underestimation of the institutions of rent regulation of breeding and genetic processes in agribusiness.

Insufficient development of rental institutions for development of genetic agriculture in the Russian Federation made raw materials and food genetically unsafe, and caused inaction of critical socially significant prevention of transnationalization of the genetic and breeding sphere in the Russian Federation.

2. Problem statement
The rental methodology of land payments makes it possible to activate the factors of genetic farming development.

1. Complication of the structure of agrarian relations with increased dynamics of the economic and political environment qualitatively changes the structure of rental income, which should be followed by adequate changes in the methodology of rental regulation.

2. The rental methodology of land payments can optimize the process of rent formation to work out mechanisms for development of production technologies and farming systems.

3. Research problem
The rental theory can be used to develop rental regulators of investment and technological processes in agribusiness.

1. The shift in priorities in land use is caused by the existing structure of rental income in the Russian Federation, in which differential rent II that determines the reasons for rational land use, is replaced by resource and, hence, monopoly rent.

As a result, incentives for the most complete and rational use of agricultural land are lost (figure 1).

If the study investigates transformation of land relations for a long-term period, to understand rental categories classical approach should be used, according to which:

differential rent II – increase in normal yield due to intensification factors;

natural resource rent – an increase in normal yield due to natural and climatic factors.

The market price of land is typically determined by economic rent, which is resource rent in the absence of rent regulators, and it devalues agricultural land and motivates rightholders to concentrate resources and monopolize that hampers competition.

Economic rent is an increase in the value of the resource to maintain it within a certain area of activity, which obliges land users to subsidize up to the level of the average yield of natural resources, but this rule cannot be observed in the context of resource rent localization.

A necessary and sufficient condition for transition to the rational land use is redistribution of resource rent and its transformation into socio-economic factors of the development of land relations.

2. Target functions of modern agricultural relations in the Russian Federation cause information asymmetry and give rise to false priorities, as they are aimed at maximizing capital and market dominance that typically occurs at the expense of fair competition.

The criterion for realization of interests in the modern agrarian economy is the amount of capital that ensures increase in the economic rent and constrains maximization of investment interests in subsoil use. This results in surplus and localization of agricultural land resources of average and poorer quality in non-production areas. Economic rent provides an outflow of capital from the real sector to the detriment of investment and innovation strategies of agribusiness development. Depending on the
degree of consistency of the structure of rental income, cadastral valuation criteria and payments for natural resources, an investment profile of the agrarian economy development is formed, which needs to be reformatted for socio-economic interests.

![Diagram of rent structure]

**Figure 1.** The rent structure of the value of gross agricultural production.

According to Rospririodnadzor data for 2017, in the territory of the Russian Federation, the area of land disturbed by various types of work amounted to 25,624.17 ha [1].

According to the Department of Land Reclamation of the Ministry of Agriculture, about 130 mln ha of agricultural land are degraded.

Every year, 1.5–2 mln ha of land are degraded in the territory of the country, which leads to losses of up to 3.9 mln tons of agricultural products in grain equivalent.

The summary data of Rosreestr on spread of the main negative processes indicates a critical scale of the problem (table 1).

| Type of negative process | Total surveyed, thous. ha | Area of negative process distribution |
|--------------------------|---------------------------|---------------------------------------|
|                          |                           | thous. ha                           | %       |
| Aeolation                 | 10,485.45                 | 1,427.17                             | 13.6    |
| Water erosion             | 10,485.45                 | 1,847.17                             | 17.6    |
| Salinization              | 10,485.45                 | 432.58                               | 4.1     |
| Waterlogging              | 10,485.45                 | 763.78                               | 7.3     |

**Table 1.** Negative processes in the territory of the Russian Federation, 2017.

4. **Purpose of study**

The study aims to identify rental levers that will eliminate information asymmetry in genetic farming development.
1. To reveal the content of socio-economic institutions for rational land use based on rental income structuring to develop rental principles of genetic farming development and soil potential restoration.

2. To study land relations in terms of the impact of rental institutions on rational land use, including the impact of genetic factors of grain crop samples adapted for Leningrad region on crop yield and soil fertility.

5. Methodology
The research methodology is based on a systematic approach that employs economic, mathematical and statistical methods.

Within the framework of general rent regulation aimed at formation of technological priorities in land relations, it is proposed to identify genetic rent to maintain a socially oriented vector of genetic farming development.

The method of calculating the differences in normal yields due to genetic factors is used to calculate the genetic rent for grain crops on the example of Leningrad region to provide substantiation of crops adapted to the region, selection decisions and agrotechnical technologies.

1. The solution to the problem of rational land use is related to the rent mechanism of organization of land relations.

A.E. Sagaidak and A.A. Sagaidak developed a modern approach to implementation of the rent mechanism in land management that considers the land rent as the basis for assessing the effectiveness of land consolidation projects in agriculture [2].

The socio-economic component of land management underlies the substantiation of the model of rational land use that is aimed at:
- involvement of lands into production turnover and improvement of soil fertility;
- prevention of land degradation;
- rational land use with increased investment and balanced fertilization;
- introduction of high-precision farming technologies to decrease the consumed fuel, seeds and fertilizers;
- engineering development of territories.

The model of rational land use and the economic barriers to its implementation perform social functions; therefore the socio-economic tasks of modern land management are primarily aimed at solving social issues of reproduction and overcoming interregional socio-economic differentiation.

The dominant social argument for rational land use is the improvement of the spatial basis of the life of society, strengthening the role of land as a means of production.

Socio-economic approaches to substantiating rational land use:
1) Compensation for social and economic damage;
2) Smoothing of socio-economic differentiation;
3) Socio-economic support of anti-erosion resistance and genetic farming development;
4) Reproduction of fertility and gene pool of cultivated plants;

Socio-economic development is aimed at transformation of social reproduction.

Transformation of social reproduction is complicated by huge differences between individual territories in terms of socio-economic development, which confirms the need to smooth interregional socio-economic differentiation in the countryside by enhancing the investment activity of land rightholders based on rental conditions for genetic farming development [3].

To date, genetic engineering, which is affected by monopoly rent, poses a real threat to land resources and hinders rational land use. Regulation of the structure of rental income can contribute to the development of competition and, accordingly, to strengthening of reproduction processes [4]. Centralization of excess profit intensifies contradiction between industrial democracy and empowerment when the shared power approach is disrupted at the expense of social production and regional competition [5].

2. Farming systems should be focused on a certain yield of agricultural crops in a specific soil and climatic zone, and on the yield increase as individual or combined factors of farming intensification
gradually increase, which depends on the socio-economic factors of formation of rental institutions for rational land use (table 2).

**Table 2.** Main socio-economic approaches to substantiating of rational land use.

| 1. Factors of social rent | Indicators | Approach |
|---------------------------|------------|----------|
| 1.1 Ecology               | Contamination level of the territory | Anthropogenic load | Compensation for social and economic damage |
| 1.2 Improvement           | Development of engineering infrastructure | State of transport infrastructure | Smoothing of socio-economic differentiation |
| 1.3 Socio-cultural environment | Medical service level | Housing level | |

| 2. Factors of genetic rent | Indicators | Approach |
|---------------------------|------------|----------|
| 2.1 Farming system        | State of cultivation | Fertility level | Development of genetic farming. Socio-economic provision of anti-erosion resistance |
| 2.2 Genetics              | Resistance to viral diseases, tolerance to cold and heat | Increased yield, species and varietal diversity of cultivated plants | Reproduction of fertility and gene pool of cultivated plants |
| 2.3 Breeding              | Varieties | Breeds | |

These systems can be characterized as farming systems of the first, second, etc. levels in relation to the district, region, territory. It is proposed to establish the levels according to the degree of utilization of photosynthetically active radiation (PAR) by plants as inexhaustible source of energy. The interval between these levels can be taken as 0.5% of the PAR utilization factor.

The process of soil formation changes through changes in vegetation. Appropriate combination of anthropogenic factors makes it possible to change the properties of soil and the direction of soil-forming process by changing the biota (agricultural crops most adapted to the soil of cultivated plants).

Developing genetic farming has brought more advanced plant species resistant to various pests and diseases. Farmers had to spend fabulous money on treating fields with harmful herbicides, but plant genetics made it possible to forget about these problems.

Genetics is a theoretical basis for breeding – creating new and improved plant varieties, strains of microorganisms, and animal breeds adapted to certain soil conditions.

Breeding needs a diversity of source material. For this purpose, N.I. Vavilov gathered a collection of cultivated plant species and their wild ancestors from all over the world. N.I. Vavilov established the centers of origin of cultivated plants with the greatest species and varietal diversity of cultivated plants.

By 1940, the collection in All-Union Institute of Plant Industry amounted to 300 thousand samples. To date, the collection is being replenished and is the basis for work on breeding of any culture.
6. Results

The proposed method of structuring rental income based on modeling of the normal yield, calculated by the methods of correlation and regression analysis.

1. Current mechanism of land relations is not able to solve the problem of rational land use due to the imbalance in the system of land income distribution.

The object of the study is agricultural land in the Russian Federation, the basis for the socio-economic development of the country, which steadily decreased from 637.7 mln ha in 1990 to 399.9 mln ha in 2010 and 383.2 mln ha in 2018 that confirms the fact of its irrational use.

The rental income distribution mechanisms promote monopolization and thus hamper normal competition. The basic principle for resource income distribution, which motivates rational land use, is the principle of competition. This principle can be implemented only in the institutional environment where the market acquires a competitive basis and a socially oriented nature.

The resource distribution criterion determines the rules for economic entities and, accordingly, the balance of competitive forces, which ultimately transforms into a certain form of competition and the model of land relations. Decreased rights and opportunities hampers competition and distortion of incentive mechanisms for labor in the real sector [6].

Therefore, substantiation of socio-economic institutions for rational land use is based on structuring of rental income and development of rental principles for genetic farming development that ensures restoration of soil potential.

Rental institutions formed by technological factors, including zonal genetic properties of cultivated plants, contribute to rational land use, subject to the socio-economic structuring and rental income distribution.

The study aimed to determine the rental approach to classification of the factors of the farming system modernization. The factors, being elements of economic potential, facilitate creation of a certain type of rent (table 3).

The resource potential that determines the source of formation of genetic rent is represented by genetic and social factors.

The production potential is a converted form of profit and differential rent II, which, in turn, indicates the cost of factors for modernization of land relations.

Socio-economic infrastructure creates relative advantages and is a converted form of differential rent II. The socio-economic value of land is formed by the rent mechanism, which is the basis for using rental approaches in the study. The management system is capable of maintaining equal competitive conditions only within a certain range, but market forces, as a rule, counteract this, shifting the structure of rental income into an asymmetric zone [7].

| Factors of the farming system modernization |
|--------------------------------------------|
| Economic potential:                        |
| Production potential:                      |
| Production technologies and equipment for plant growing enterprises, farms, processing enterprises, machine and tractor fleet, storage facilities, elevators |
| Socio-economic infrastructure              |
| Natural and climatic factors:               |
| soil fertility; location.                  |
| Scientific and technical factors:          |
| mechanization of production; personnel training; innovation in breeding etc. |
| Genetic potential:                         |
| species diversity;                         |

Table 3. Rent factors of the farming system modernization.
6.2. Methodological techniques were developed to identify genetic rent that contributes to rational land use, which is the novelty of the study.

The study showed that rent regulation of land relations is reduced to socialization of differential rent I (natural resource rent) through the land tax and its use to create socio-economic infrastructure.

Differential rent II and its forms, including genetic rent, are institutions for rational land use.

The problem of a long-term imbalance between production, genetic and social factors is due to the structure of rental income and its transformations in short-term dynamics.

Therefore, it is necessary to study the process of rent formation, to identify and assess the structure of rental income, and to develop rent-oriented institutions for genetic farming development, restoration of soil potential and fertility.

To do this, the crop yield is determined first (Y with a minimum of all diagnostic characteristics (Y min), as a base value for comparison for each calculated Y (Y calc).

Y calc 1 is then determined for each type of sample, while X1 takes its value for a certain sample, and all other values of X remain unchanged as they were at Y min. Y calc 2,3,4,5 are determined similarly.

After that, the yield increase due to the quality of genetic trait (genetic rent) is calculated as Y calc 1 – Y min. Similarly, genetic rent is calculated for Y calc 2,3,4,5. The results are summarized in table 4.

Table 4. Determination of the impact of genetic factors on the normal yield of zonal crops as of 01.01.2020 (fragment).

| Yield, g/m² (Y) | Mass of 1000 grains, g (X1) | Plant height, cm (X2) | Seedlings—wax ripening, days (X3) | Earing—wax ripening (X4) | Sprouting—earing, days (X5) | Y calculated | Genetic Rent (Y calc 2 - Y min) |
|----------------|-----------------------------|----------------------|-----------------------------------|--------------------------|---------------------------|--------------|-------------------------------|
| 265            | 38                          | 141                  | 110                               | 64                       | 46                        | 333.7099854 | 147.42                        |
| 145            | 36                          | 131                  | 101                               | 57                       | 44                        | 292.8923633 | 131.22                        |
| 265            | 43.4                        | 101                  | 93                                | 56                       | 37                        | 220.0493058 | 82.62                         |
| 190            | 38                          | 110                  | 104                               | 55                       | 49                        | 307.4489757 | 97.20                         |
| 240            | 38                          | 120                  | 108                               | 59                       | 49                        | 323.6676308 | 113.40                        |
| 190            | 37                          | 110                  | 90                                | 46                       | 44                        | 263.1128945 | 97.20                         |
| 300            | 41                          | 115                  | 91                                | 47                       | 44                        | 288.3859464 | 105.30                        |

The results of the study clarify the methodology for structuring rental income and allow additional structuring of differential rent II in relation to the genetic properties of plants and soil characteristics, as well as the development of recommendations for institutions for rational land use.

In the study, a social-rent model was developed for substantiation of the genetic rent limits, which contribute to the development of genetic farming, the smoothing of intersectoral differentiation of income, the formation of a competitive environment, and the development of social prerequisites for
increase in the level of agricultural education.

The main reason for the low level of education of those employed in the countryside is reduced dependence of production factors on rental income drivers. Monopolization of industries yielded a new term—“surplus resources”. “The product becomes less resource-, labor-, and capital-consuming” [8].

7. Conclusion

To date, genetic rent is suppressed by monopoly rent. Genetic engineering, which is affected by monopoly rent, poses a real threat to land resources and hinders rational land use.

1. The economic and mathematical model of the theoretical yield is obtained in the form of a regression equation (correlation relationship), which characterizes the dependence of the crop yield on its genetic factors by means of correlation and regression analysis.

The calculation of genetic rent was performed based on modeling of the theoretical yield due to the correlative impact of genetic factors.

In order to carry out the transformation of genetic rent into socio-economic factors of rational land use, it is necessary to identify factors that significantly affect the theoretical yield. To do this, it is necessary to calculate combinations of paired correlation coefficients between Y and X factors.

2. Knowing X1 and X5, it is possible to model the yield value and the technological policy X1 with regard to X5, provided that the genetic rent is maximized.

Affecting the process of resource income distribution, it is possible to promote the competition and rational use of land resources.

The identification of genetic rent in the structure of rental income, as an additional product due to the genetic properties of plants in zonal conditions, will promote genetic farming and rational land use through exemption from tax of this part of the production cost.

Covering the deficit of innovative resources through subsidies will create a competitive environment and prevent speculation with land.

Agreement of the interest rate with the growth rate of differential rent II, including genetic rent, will allow redirecting credit resources to land management projects for rational land use.

Overcoming information asymmetry in genetic farming gives the prospects for development of the agrarian sector, which is the basis of the national security of the country in severe conditions of the modern world [9].

Strengthening the resource of basic industries contributes to food independence of the country and forms the basis for convergence of political, economic, technological and management systems in the world economy [10]. In these conditions, globalization can become a mechanism for the effective exchange of technologies, innovations and knowledge.

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