Introduction of Crop Insurance Index Using Digital Technologies

O Rusakova¹, S Golovan¹

¹The Department of Finance and Accounting, Irkutsk State Transport University, Irkutsk, Russian Federation

E-Mail: rusakova.OI@yandex.ru, free9sonjas@gmail.com

Abstract. The article is devoted to the study of prospects for the introduction of crop insurance index in the Irkutsk region. To introduce this type of insurance one of the digital technologies should be used - big data technology. The analysis made it possible to assume that for the Irkutsk region the most satisfying is the introduction of an index insurance based on regional yield.

1. Introduction

Agriculture is a strategic sector of the economy of any state, aimed at providing the population with food and obtaining raw materials for number of industries. The industry is one of the most important, represented in almost all countries.

Currently, the following goals of digitization of agriculture are highlighted [11]:
• Growth of the contribution to the economy in 2024 to 5.9 trillion. rub.;
• Increase in export earnings of enterprises to $ 45 billion;
• Improving management efficiency;
• Creation, dispatching and aggregation of data flows to create end-to-end chains from agricultural production to consumption with deep integration into related sectors of the digital economy;
• Involvement of new professions in agricultural production;
• Increase farm incomes and quality of life in the countryside;
• Development of conditions for subsidizing the installation, processing and transmission of data from cyber-physical systems (Internet of Things platforms), as a principle of encouraging the introduction of digital solutions;
• Improving the efficiency of interaction of participants among themselves and with the state with the transition to digital data exchange format, reduction of types of reporting;
• Formation of conditions for the transition of the industry to the end-to-end production cycle with minimization of intermediaries and trading margin;
• Creation of a generally accessible structured bank of knowledge and technologies in the context of agricultural sub-sectors and regions.

Based on the listed goals of the digital transformation of agriculture, it can be concluded that one of the directions of such development is to increase the efficiency of both the management and the interaction of representatives of the industry among themselves and with the state. This provision leads us to consider the need to introduce agricultural insurance with the use of innovative digital technologies, which will facilitate the integration of objective data flows of agricultural producers and
the state to ensure global planning in the industry and provide recommendations to market participants. All this becomes possible with the use of crop insurance index insurance.

2. Relevance of the problem
The relevance of the research topic of digitalization is confirmed by numerous studies in the scientific literature. The need to develop a phased digitalization scenario for agriculture in the Russian Federation was discussed at a conference organized by the Analytical Center under the Government of the Russian Federation on May 21, 2018 in Moscow [11]. According to the data presented by the authors, in 2017 the amount of investment in information and communication technologies amounted to 3.6 billion rubles, or 0.5% of total investments in fixed assets. This is the lowest indicator by industry, which indicates, among other things, the low digitization of the domestic agro-industrial complex and the competitive advantage of foreign producers.

Researchers from the PRC, based on an analysis of the characteristics of modern agriculture, are proposing the concept of digital agriculture. Analyzed the relationship between precision farming, information agriculture, virtual agriculture [9].

The approach to digitization of agriculture based on Big Data technology is widely popular in modern studies. The authors present a new approach to the mapping of agricultural fields, based on the effective extraction of a huge set of simple, highly correlated and interdependent traits [3].

Considering that in our study, the relevance of introducing index insurance of crops based on the use of digital technologies is considered, it is also necessary to dwell on the problem of digitalization of the insurance market in the literature. This issue is addressed by such Russian scientists as: O.I. Rusakova A.A. Tsyganov, D.V. Bryzgalov, T.V. Polteva, N.N. Bykova, [6;8;10] In the foreign literature of interest are numerous works on the use of new technologies in the insurance business [4;5;7]

Such authors as Bezverhaya O.N, Vlasova N.I, Belova E.V are engaged directly in index insurance in agriculture [1;2].

3. Statement of the theoretical problem
To substantiate the significance of the topic under study, it is necessary to establish the relationship between innovative forms of insurance (in this study, index insurance) and increasing the efficiency of agricultural producers by switching to digital data exchange format. Considering the long period of digitalization of the insurance market itself, the use of innovative technologies for insurance inevitably leads to the digitalization of the object itself, which is of interest from the point of view of insurance protection, in this study - the agricultural sector.

Currently, scientists use the following characteristics of the digitalization of the insurance market (Table 1.)

| Table 1. Characteristics of the main areas of digitalization of the insurance market*. |
| --- |
| **Direction** | **Definition** | **Digital Technologies Used** |
| Internetization | The use of the Internet in business processes | New production technologies; wireless technology; cloud technologies. |
| Individualization | Development of individual insurance proposals | Big Data Technology |

Note: *The table is not fully translated and may require further clarification or context from the original source.
The individualization of economic relations, the departure from mass standardized products on the insurance market are manifested in the individualization of insurance companies’ offers.

Individualization of the insurance offer implies:

• individual risk assessment by increasing the amount of information collected about the policyholder and the insurance object;

• preparation of an individual insurance offer upon request of the insured.

The digital economy provides the ability to create individual offers without significantly increasing the value of a product with a help of modern technologies. Individualization of insurance services will largely depend on the level of development of big data technology in combination with the collection of large amounts of information via the Internet.

At present, the main problems of individualization in the insurance market are [10]:

• insufficient development of the degree of influence of the collected indicators on the risk;

• excessive risk minimization due to a more accurate assessment, reduction in the size of the net rate is significantly lower than the level of expenses of the insurer to enter into an insurance contract;

• approaching the risk-free nature of the insurance contract;

• the legality of using the collected data on the policyholder.

Thus, the relationship between digitalization of the insurance market and the agricultural sector is, in our opinion, the development of the direction of individualization, that is, the development of individual proposals based on the analysis of a large amount of data (Fig. 1). This technology is used when introducing index insurance.
Figure 1. The relationship of digitalization of the insurance market and the agricultural sector.

Index insurance is insurance that is associated with indices such as rainfall, temperature, humidity or yield and not actual losses. (fig.2)

Figure 2. The generally accepted classification of agricultural crop insurance.

This approach solves some problems that limit the use of traditional crop insurance.

The task of agricultural crop insurance is to protect the income of agricultural producers from the negative impact of external risks. It is based on the refusal to assess the damage caused to a particular farm. At the same time, the only information that the agricultural commodity producer should provide to obtain insurance protection is the information on the size of the sown area, confirmed by the relevant reports.

Conducting agricultural crop insurance is based on the following principles [1]:

• equal insurance rates in the region;
• specifying in the contract an indicator of the occurrence of an insured event in the form of a certain percentage of the normal index value, the value of which determines the level of insurance coverage;
• conclusion of contracts only until the moment when information about the insured risk (for example, the weather forecast for the upcoming season) becomes publicly available;
making an insurance payment in an amount proportional to the percentage change in the actual value of the index in comparison with the established indicator within the range of values, or in the amount of the full sum insured.

Considering the above problems of individualization in insurance, we can conclude that from the point of view of the development of index insurance as an element of this direction, the most important is the insufficient development of the degree of influence of the collected indicators on risk. This leads to a situation where index insurance of crops does not always correspond to the climatic features. As a result, there are frequent cases when the occurrence of losses in a separate farm does not entail an insurance payment, since the level of regional yield exceeds the value of the established index, and vice versa, despite the real losses.

4. Practical importance
In this study, the goal was set to analyze the most preferred option for introducing crop insurance in the Irkutsk region: based on weather indices or a crop index. According to the literature, the most common in developed countries received insurance with the use of precipitation index. It is used in assessing risks such as drought or, conversely, waterlogging [1]. At the same time, for regions with a sharply continental climate, this statement is put into question by us, which suggests the idea of introducing an index of regional yield, as more promising. Index yield insurance is carried out for a group of farms of one region or one natural-climatic zone. An important problem is the determination of the geographical area (insurance unit) to which the insurance coverage applies. It is established the fact that the whole zone has similar climatic conditions and production technology.

As we established earlier, the main ways of developing digital technologies in the field of crop insurance should be sought in the direction of individualization of insurance proposals based on the technology of analyzing large amounts of data - the introduction of index insurance.

We have analyzed the dynamics of the gross harvest of crops in the Irkutsk region for 2012-2017. (Table 2 and Figure 3).

| Name of culture | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Growth rates of 2017/2012, % |
|----------------|------|------|------|------|------|------|-----------------------------|
| Cereals and legumes (in weight after processing) | 632,1 | 796,5 | 862,0 | 556,5 | 771,9 | 871,6 | 38,6 |
| Potatoes (prom. Sector) | 81,1 | 64,2 | 77,9 | 51,4 | 56,9 | 41,0 | -49,4 |
| Vegetables (industrial sector) | 36,9 | 26,2 | 25,9 | 20,4 | 21,4 | 19,4 | -47,4 |

* Based on data of the Territorial Body of the Federal State Statistics Service for the Irkutsk Region (http://irkutskstat.gks.ru).
Based on the analysis, it can be concluded that the largest gross collections in absolute terms and the basic growth rates (+38.6%) were obtained by the total yield of grain and leguminous crops. At the same time, the fees of potatoes and vegetables in the industrial sector in 2017 demonstrated a decrease compared to the beginning of the period (-49.4% and -47.4%), respectively.

**Figure 3.** Gross collections of main crop crops in the Irkutsk region, thousand tons.

The development of a weather index usually goes through the following steps:
1) checking how weather variables influenced or did not affect yield over time;
2) discussing major weather factors with experts, such as agrometeorologists, and manufacturers;
3) reference to crop models that use weather variables as input parameters for estimating yields.

Given that the index based on precipitation is widely applicable, in this study we will assume that its effect on crop yield is proven. Therefore, let us proceed to the stage of modeling the situation if index insurance of crops was introduced for use in 2017 on the historical rate of precipitation in the region (Table 3 and Figure 4).

**Table 3.** The dynamics of precipitation in the Irkutsk region, 2017*.

| Month | Historical rainfall, mm | Actual rainfall, mm | Deficiency / surplus (mm) | Relation to normal, percent |
|-------|-------------------------|---------------------|---------------------------|-----------------------------|
| January | 17,5 | 10 | -7,5 | 57 |
| July | 140,6 | 90 | -50,6 | 64 |

* Based on Rosgidromet data.

In this study, we used the recommended values of the historical index depending on the level of precipitation (70-80%) and the level of regional yield (50-90%). Based on the collected data, conditional values were simulated by the level of insurance compensation for 2017 using the precipitation index and regional yield.
Thus, we have established that in the generally accepted practice, the occurrence of an insured event using the precipitation index is recorded with an average precipitation amount below 70-80% of the historical norm. In our study, the actual average precipitation was 60.5% (Table 3).

The insurance indemnity in 2017 would be from 9.5-19.5% of the sum insured. At the same time, it can be concluded that the yield of grain and leguminous crops, which occupy the main share in the gross collections in the Irkutsk region and are of primary interest from an insurance point of view, showed an increase, despite a significant drop in precipitation.

This is an example of exactly the situation when the precipitation index does not reflect the real situation due to the characteristics of the regional climate. In this case, insurers are forced to set sufficiently high insurance premium levels in order to adjust the need to make payments when the index deviates from the actual value in favor of agricultural entrepreneurs.

At the same time, the survey results show that actuarial-based insurance premiums for index insurance significantly exceed the willingness of agricultural entrepreneurs to pay current insurance services [1].

Table 4. Simulated values of insurance compensation when using the precipitation index and regional yield in 2017 year.
| Insurance based on precipitation index | Value |
|----------------------------------------|-------|
| Indicator                              |       |
| Coverage, % (of historical average amount (index) of precipitation) | 70-80% |
| Adjusted actual average precipitation from historical index, % | 60.5% |
| Estimated damage, % (coverage - adjusted actual precipitation index) | 19.5% |
| Insurance compensation                |       |
|                                       |       |

| Insurance based on regional yield index | Value |
|----------------------------------------|-------|
| Average five-year yield of grain and leguminous, thousand tons | 718.4 |
| Insurance coverage (50-90%), thousand tons | 359.2-646.6 |
| Insurance compensation (insurance amount *% of the fall in the regional crop yield in the current year relative to the value of the index) | Missing |
| Average five-year potato yield, thousand tons | 66.3 |
| Insurance coverage (50-90%), thousand tons | 33.2-59.7 |
| Insurance compensation (insurance amount *% of the fall in the regional crop yield in the current year relative to the value of the index) |       |
| Average five-year crop yield of vegetables, thousand tons | 26.2 |
| Insurance coverage (50-90%), thousand tons | 13.1-23.6 |
| Insurance compensation (insurance amount *% of the fall in the regional crop yield in the current year relative to the index value) |       |
| Insurance amount *[0-17.8]% |       |
5. Conclusion

During the study, we justified the approach to assessing the introduction of index insurance of crops using digital technologies in the territory of the Irkutsk region. This technology is used by introducing index insurance. The analysis made it possible to assume that for the Irkutsk region the most satisfying interests of the insurer and policyholders, as two parties to the insurance transaction, is the introduction of an index based on regional yield. This index shows the real climatic situation in the region when forecasting the amount of insurance coverage, which contributes to the formation of a more adequate tariff policy of insurers. At the same time, according to researchers of this problem, index insurance of agricultural crops is suitable for such crops as wheat, rye, sunflower, sugar beet. The introduction of index insurance should be accompanied by an actuarial justification of insurance tariffs, the establishment of a corridor of values of tariff rates in relation to culture and the chosen value of the index for the territorial unit where the producer’s agricultural lands are located [2].

6. References

[1] Belova E V 2018 INDEX AND MULTI-RISK INSURANCE PRODUCTS IN AGRICULTURE: DEVELOPMENT PROSPECTS Agrarian Scientific Journal 4 63-67
[2] Bezverkaya O N, Vlasova N I 2015 The relevance of introducing a precipitation index for crop insurance with the use of modern agricultural technologies News of the Orenburg State Agrarian University 3(53)
[3] Debats S R et al 2016 A remoteized sensing environment vol 179 210-221
[4] Porrini D 2017 Regulating Insurance Market in the European Insurance Markets and Companies 8 1 6-15
[5] Renuka S, Dinesh G P 2018 Impact of New Trends on Banking and Insurance Asian Journal of Management vol 9 3 1149-1151
[6] Rusakova O I, Ivanova T A 2016 ACTUAL PROBLEMS OF ECONOMIC COOPERATION OF RUSSIA AND CHINA IN THE FIELD OF AGRICULTURAL INSURANCE Development of Russian-Chinese Relations: A New International Reality: Proceedings of the 2nd International. scientific-practical conf., dedicated. 70th anniversary of Victory in the Second World War Irkutsk: BSU Publishing House
[7] Scardovi C 2017 Transformation in Insurance Digital Transformation in Financial Services Springer Cham 163-185
[8] Polteva T V Bykova N N 2017 The current state of the digital financial technology market in Russia Karelian scientific journal vol 6 4(21)
[9] Tang S et al 2002 A conception of digital agriculture IEEE International Geoscience and Remote Sensing Symposium vol 5 3026-3028
[10] Tsyganov A A, Bryzgalov D V 2018 Digitalization of the insurance market: tasks, problems, prospects Economy Taxes Right vol 11 2 111-120 https://cyberleninka.ru/article/n/tsifrovizatsiya-strahovogo-rynka-zadachi-problemy-i-perspektivy
[11] Digitization of agriculture in the Russian Federation https://iotas.ru/files/documents/%D0%9F%D1%80%D0%B5%D0%B7%D0%B0%D1%82%D0%BD%D1%82%D0%B0%D1%86%D0%B8%D1%8F%20eAgro%200000.pdf