The impact of variety on the effectiveness of crop insurance with state support

K Zhichkin¹, V Nosov², L Zhichkina³, O Grigoryeva⁴, V Kondak⁴ and T Lysova⁴

¹Department of Economic Theory and Economics of AIC, Samara State Agrarian University, 2 Uchebnaja Street, Kinel 446442, Russian Federation
²Department of economics and management, K G Razumovsky Moscow State University of Technologies and Management, 73, Zemlyanoy val, Moscow 109004, Russian Federation
³Department of Land Management, Soil Science and Agrochemistry, Samara State Agrarian University, 2 Uchebnaja Street, Kinel 446442, Russian Federation
⁴Department of Accounting, Analysis and Audit, Saratov State Vavilov Agrarian University, 1 Teatralnaya squre, Saratov 410012, Russian Federation

E-mail: novla@list.ru

Abstract. The article discusses the issues of agricultural crops varieties resistance in relation to various natural and climatic factors. The damage from the occurrence of emergencies in agricultural production is 95% of the damage arising in crop production. Therefore, crop insurance with state support has significant development potential, especially in regions with dry, sharply continental climate (for example, in the Samara region). At the same time, the impulse associated with the Federal Law No. 260-FZ adoption was completely exhausted and in recent years there has been a decrease in the crop insurance with state support (including the number of contracts, amount of covered area, insurance coverage, etc.). One of the reasons for this is the high cost of insurance rates. To reduce it, it is proposed to introduce the concept of “crop yields sustainability” and calculate the insurance rate depending on the productivity of a particular variety, shown for a long time in climatic conditions similar to farm conditions. To do this, one can use the array of data on crop yields of various varieties obtained by research institutes in the framework of the project “The World Collection”. Negative deviations from the average yield with the same cultivation technology and soil parameters form losses of agricultural producers due to the biological characteristics of this variety and its response to prevailing weather conditions. Thus, it is possible to adjust the amount of insurance payments, reducing them for those varieties that guarantee stable yield for the farms in a given territory.

1. Introduction

According to the World Bank, crop insurance accounts for a significant share of the world agricultural insurance market. More that 90% of the insurance premium collected is financed by crop insurance [1]. In the Russian Federation crop farming accounts for more than 95% of emergency losses in the agricultural sector [2]. This reflects the importance of crop insurance for the Russia agro-industrial complex. Yet in the Samara region crop insurance with state support is still not used widely, even given close attention from the government. Since 2014 there has been a decrease in the number of contracts on state-supported crop insurance (from 114 in 2014 to 0 in 2017) [3]. The region is located in an area hazardous for agriculture, and natural and climatic factors have a key influence on the
efficiency of crop farming in agriculture organizations. In this, according to the Federal Agency for State Support of the Agro-Industrial Complex, crop losses ranged from 11.1% in 2016 to 25.8% in 2017, which means that during the period under review agricultural producers collected 0.185 rubles of indemnities for 1 ruble of insurance premiums [4].

Another reason for reduction of the state-supported crop insurance market is a high insurance premium, which a company pays during spring field works, diverting financial resources from the primary objective – providing a sound cultivation technology (acquisition of chemicals, spare parts, fuel, salary payment, etc.) [5].

In this regard insurance rates are typically set for a group of crops [6,7] without being separated by varieties and cultivation technologies [8-10]. Though it is known that variety of crop affects its resistance to drought and, therefore, the amount of crop yields reduction [11,12]. Which is why when calculating insurance rates, it is necessary to take into account the variety of a cultivated crop.

The purpose of the research is to clarify the methodology of determination of insurance rates in crop insurance with state support.

Among objectives the following can be named:
- to identify the possibilities for using data obtained from "The World Collection" program to generate specifying coefficients for insurance rates calculation;
- to propose a system of indicators for specifying coefficients calculation;
- to develop an algorithm for specifying coefficients calculation.

2. Materials and methods

Economic aspects of insurance rates determination in crop insurance with state support are the main targets of the research. The methodology of the research involves analysis of the economic mechanism of losses incurred by an agricultural unit from the impact of crop varieties peculiarities on yields. Abstract-logical method, situational method and system analysis were implemented during the research.

To test the theory in the conditions of the Samara region we used data on yields of spring barley varieties of domestic and foreign selection, provided by the Federal State Budget Scientific Institution “Povolzhsky Research Institute Selection and seeds n.a. P N Konstantinov”, located in Kinel district, for 2007-2016.

3. Results of the research

To correct the level of insurance rate it is proposed to anchor it to the indicator of yield stability of varieties. We believe that yield stability of a variety means stability of biological and technological characteristics of the variety, reflected in genetically designed adaptive properties of varieties, which allow to compensate some negative external influence (adverse climatic conditions, damage of plants by diseases and pests). The wider bounds of a possible adaptation are, the more the variety meets the conditions of cultivation (in that territory).

As an estimation criterion it is proposed to use the data collected by breeding facilities and science institutes as part of “The World Collection” program. Each year specialized research institutes sow a wide spectrum of varieties of domestic and foreign selection of different crops. Small sizes of sample plots allow to concentrate all plantings on a limited area providing single temperature and soil conditions for all the varieties studied. The single cultivation technology makes it possible to equalize the technological influence on results of varieties cropping. As a result it can be said that only biological characteristics of a variety influence productivity, which is important in evaluating with respect to sustainability of crop yields.

To test the theory we used data on yields of spring barley varieties of domestic and foreign selection, provided by the Federal State Budget Scientific Institution “Povolzhsky Research Institute Selection and seeds n.a. P N Konstantinov” (Table 1).

Calculation of studied varieties yields linear trend equation failed to produce reliable results, as the validity of functions was very low (ranged from 0.08 to 0.32) due to significant differences in the
weather conditions variables during the researched period, which required either increasing complexity of functions (difficult to explain within the existing theory), or use of other indicators for evaluation.

| Variety       | Allowed in the Samara region | 2007  | 2009  | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  |
|---------------|------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| K 9267 local  | No                           | 15.00 | 24.65 | 5.00  | 38.60 | 11.50 | 11.70 | 26.25 | 29.33 | 27.70 |
| Agate         | Yes                          | 15.00 | 23.70 | 8.30  | 35.40 | 15.55 | 11.65 | 32.95 | 34.00 | 25.00 |
| Anna          | Yes                          | 17.10 | 17.45 | 11.10 | 36.00 | 14.15 | 7.85  | 37.65 | 33.00 | 28.00 |
| Compatriot    | No                           | 28.70 | 27.80 | 5.15  | 26.00 | 10.55 | 9.50  | 38.85 | 28.67 | 18.30 |
| Nutans 553    | Yes                          | 14.00 | 15.00 | 9.35  | 43.20 | 11.30 | 16.95 | 29.30 | 36.33 | 24.00 |
| Orenburg 15   | No                           | 21.00 | 23.60 | 10.70 | 30.35 | 16.20 | 11.00 | 31.85 | 34.00 | 27.70 |
| Orenburg 17   | No                           | 19.50 | 27.90 | 9.60  | 30.10 | 12.20 | 11.05 | 28.05 | 33.00 | 26.00 |
| Spomin        | No                           | 17.80 | 21.15 | 7.45  | 30.75 | 10.30 | 11.85 | 29.65 | 31.00 | 24.00 |
| Zernograd 244 | No                           | 9.50  | 15.40 | 12.00 | 36.45 | 14.30 | 9.60  | 33.35 | 33.33 | 29.30 |
| Orenburg 16   | No                           | n/a   | 26.60 | 10.70 | 30.55 | 14.50 | 10.25 | 28.55 | 31.33 | 25.70 |
| Pryazovia 9   | No                           | 11.80 | 9.80  | 13.45 | 41.40 | 16.35 | 10.15 | 29.85 | 30.00 | 33.00 |
| K 9277        | No                           | 8.50  | 21.70 | 10.40 | 15.25 | 8.65  | 2.30  | 19.65 | 22.67 | n/a   |
| K 9278        | No                           | 3.50  | 17.50 | 9.75  | 18.20 | 8.35  | 3.55  | 26.60 | 28.33 | n/a   |
| MK47          | No                           | 19.00 | 28.25 | 6.55  | 31.00 | 9.75  | 12.20 | 16.30 | 28.67 | n/a   |
| Bezenchuk 2   | Yes                          | 11.50 | 11.00 | 16.50 | 20.00 | 6.50  | 8.70  | 29.35 | 37.00 | n/a   |
| Belgorod      | No                           | 18.00 | 21.60 | 5.75  | 27.80 | 8.30  | 11.90 | 34.00 | 28.00 | n/a   |
| Knight        | No                           | n/a   | n/a   | 9.45  | 31.05 | 16.85 | 13.05 | 30.80 | 35.00 | 25.00 |
| Zernograd 584 | No                           | 6.50  | 14.90 | 4.15  | 18.25 | 11.60 | 9.40  | 25.45 | 22.67 | n/a   |
| Zernograd 813 | No                           | 14.50 | 10.30 | 3.00  | 24.20 | 6.50  | 7.90  | 25.70 | 17.67 | n/a   |
| K665          | No                           | 12.00 | 9.00  | 6.90  | 24.05 | 8.95  | 7.90  | 20.30 | n/a   | n/a   |
| Sea Eagle     | Yes                          | n/a   | n/a   | 7.50  | 38.25 | 6.50  | 12.85 | 30.80 | 34.67 | 29.00 |
| Chakin 221    | No                           | 30.20 | 27.30 | 4.45  | 15.85 | 9.30  | 11.85 | 29.55 | 17.67 | n/a   |
| Hawk          | Yes                          | n/a   | n/a   | 10.70 | 31.70 | 8.75  | 8.40  | 32.30 | 36.33 | 23.70 |
| Average yield | 15.43                        | 19.73 | 8.60  | 29.32 | 11.17 | 10.07 | 29.00 | 30.12 | 26.17 |

* Data obtained from the world collection of the FSBSI “Povolzhsky Research Institute for Measuring Systems”

As a result of the analysis of data available for variety resistance evaluation, we propose to use two indicators: deviation of variety yield from the average yield of all varieties studied on an annual basis, or an average negative deviation of variety yield from the average yield of all varieties studied on an annual basis (Table 2). In the first case both positive and negative deviations of yield are taken into account, in the second case – only negative. Use of negative deviations only allows to evaluate exactly the amount of potential damage of variety, which is important when concluding insurance contracts.

According to the Rules of crop insurance with state support, varieties, not listed in the State Register of Selective Breeding Results Permitted for Use, cannot be insured. At the same time, basing on empirical data, one can see that biological and technological characteristics of some varieties (Orenburg 15-17, Knight, etc.) correspond to recognized varieties of spring barley of local selection (Agate, Anna, Sea Eagle, Hawk). Based on the studies, it can be noticed that when defining the rules for crop insurance with state support, it is necessary to use learnings and experience of local research
correction coefficients for base insurance rates of crop insurance is presented in the
Stavropol, Syzran, Cheln, Isakl, and Chvorostyanka Bolsheglushiz
rates for varieties. The first group includes farm units
located in a steppe zone of the region, and the second one
Research Institute for Measuring Systems n.a. P
conditions of regions and natural and climatic zones
Zernograd 813

| Variety     | Linear trend equation | Sum of deviations from the average yield for the entire period | Deviations from the average yield per 1 year | Sum of negative deviations from the average yield for the entire period | Average value of negative deviations from the average yield per 1 year |
|-------------|-----------------------|----------------------------------------------------------------|---------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------|
| K 9267 local | $y = 1.3407x + 14.378$ | 10.11                                                           | 1.12                                        | -7.58                                                                  | -0.84                                                                 |
| Agate       | $y = 1.6075x + 14.357$ | 21.93                                                           | 2.44                                        | -1.90                                                                  | -0.21                                                                 |
| Anna        | $y = 1.92x + 12.878$   | 22.68                                                           | 2.52                                        | -4.50                                                                  | -0.50                                                                 |
| Compatriot  | $y = 0.1985x + 20.51$  | 13.90                                                           | 1.54                                        | -17.29                                                                 | -1.92                                                                 |
| Nutans 553  | $y = 1.9607x + 12.356$ | 19.81                                                           | 2.20                                        | -8.33                                                                  | -0.93                                                                 |
| Orenburg 15 | $y = 1.3492x + 16.188$ | 26.78                                                           | 2.98                                        | 0.00                                                                   | 0.00                                                                  |
| Orenburg 17 | $y = 0.9858x + 17.004$ | 17.78                                                           | 1.98                                        | -1.13                                                                  | -0.13                                                                 |
| Spomin      | $y = 1.3308x + 13.785$ | 4.33                                                            | 0.48                                        | -4.20                                                                  | -0.47                                                                 |
| Zernograd 244 | $y = 2.4807x + 9.0667$ | 13.61                                                           | 1.51                                        | -10.72                                                                 | -1.19                                                                 |
| Orenburg 16 | $y = 1.031x + 17.633$  | 13.99                                                           | 1.75                                        | -0.93                                                                  | -0.12                                                                 |
| Pryazovia 9 | $y = 2.4492x + 9.5097$ | 16.18                                                           | 1.80                                        | -13.68                                                                 | -1.52                                                                 |
| K 9277      | $y = 0.691x + 10.531$  | -44.33                                                          | -5.54                                       | -48.09                                                                 | -6.01                                                                 |
| K 9278      | $y = 2.7271x + 4.2479$ | -37.67                                                          | -4.71                                       | -38.81                                                                 | -4.85                                                                 |
| MK47        | $y = 0.0433x + 18.77$  | -1.73                                                           | -0.22                                       | -17.63                                                                 | -2.20                                                                 |
| Bezenchuk 2 | $y = 2.778x + 5.0679$  | -12.90                                                          | -1.61                                       | -28.02                                                                 | -3.50                                                                 |
| Belgorod    | $y = 1.5589x + 12.404$ | 1.90                                                            | 0.24                                        | -9.37                                                                  | -1.17                                                                 |
| Knight      | $y = 2.4464x + 13.243$ | 16.74                                                           | 2.39                                        | -1.17                                                                  | -0.17                                                                 |
| Zernograd 584 | $y = 2.0838x + 4.7379$ | -40.53                                                          | -5.07                                       | -40.96                                                                 | -5.12                                                                 |
| Zernograd 813 | $y = 1.1451x + 8.5682$ | -43.68                                                          | -5.46                                       | -43.68                                                                 | -5.46                                                                 |
| K665        | $y = 0.8839x + 9.1929$ | -34.22                                                          | -4.89                                       | -34.22                                                                 | -4.89                                                                 |
| Sea Eagle   | $y = 2.9157x + 11.133$ | 15.11                                                           | 2.16                                        | -5.77                                                                  | -0.82                                                                 |
| Chakin 221  | $y = -0.7239x + 21.53$ | -7.28                                                           | -0.91                                       | -31.95                                                                 | -3.99                                                                 |
| Hawk        | $y = 2.5646x + 11.439$ | 7.42                                                            | 1.06                                        | -6.56                                                                  | -0.94                                                                 |

In the Samara region there are two research institutes that take part in “The World Collection”
program: the Tulaikov Research Institute for Agriculture (Bezenchuk district) and Pvolzhsky
Research Institute for Measuring Systems n.a. P N Konstantinov (Kinel district). The first one is
located in a steppe zone of the region, and the second one - in a forest-steppe zone. Therefore, all farm
units of the region can be divided into two groups, and location of units will influence the insurance
rates for varieties. The first group includes farm units, located in: Alekseevka, Bolshechernigovka,
Bolsheglushiza, Borskoe, Bezenchuk, Bogatoe, Krasnoarmeysk, Neftegorsk, Privolzhsky, Pstravka
and Chvorostyanka districts. The second group includes farm units, located in: Volzhsk, Elchovka,
Isakly, Kamishla, Kinel, Kinel-Cherkassy, Clavlino, Koshki, Krasnoyarsk, Pohvistnev, Sergiyevsk,
Stavropol, Syzran, Chelnovershiny, Shentala and Shigony districts. The framework for calculation of
correction coefficients for base insurance rates of crop insurance is presented in the figure 1.
4. Conclusion
State-supported crop insurance is now facing a crisis. Numerous causes of this crisis include high costs of insurance. The proposed framework will allow for accurate consideration of risks related to adaptation mechanisms of some varieties. Using opportunities offered by "The World Collection" program, carried out by agricultural research institutes, we can identify the amount of risks that agricultural producers face when choosing a certain variety on the territory. It is proposed to carry out the assessment of risks basing on the indicator "average value of negative deviations from the average yield of all considered varieties per 1 year". Combining the data from all institutions into a single system, we can ensure accuracy in assessment of risks related to crop varieties use in the area of responsibility of every scientific institution. Use of indicators and the whole system will make it possible not only to decrease the amount of insurance premiums, but also encourage farm units to use new modern varieties with high resistance and productive capacity.

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