Insurance Problems and Prospects in Latvian Agriculture
Apdrošināšanas problēmas un perspektīvas Latvijas lauksaimniecībā

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Abstract. Agriculture is subject to the impact of natural risks, which results in annual losses suffered by agricultural producers. The State, at its own expense, compensates agricultural producers for losses, with the subsidies amounting to LVL 2.1 million on average. Since 2000, the insurance scheme for insuring risks in crop farming sector established by the Ministry of Agriculture has provided for subsidizing persons involved in growing of crops, in the amount of 50% of the insurance premium payments. The necessity of the involvement of the State in the agricultural risks (systematic risk) management has been historically proven in EU Member States and other counties. In the European Union, cereal crop risk management is effected on two levels: governmental emergency funds *(ad hoc)* and private insurance. The experience of the EU and other countries shows that the public and private partnerships are possible on both levels and in different proportions as far as compensated losses are concerned. Procedures and requirements for the formation of emergency funds are set and defined on the European Union level. This paper is based on monographs of agricultural risk insurance specialists and EU documents on agricultural risk insurance, such as Commission Regulations, the research summarizing the experience of Latvia and other countries. These publications do not contain methodological or other solutions for agricultural risks and their insurance. An important factor of the relevancy of the theme is the necessity of a special original model for the crop risk insurance service, defining the methods for calculating coverage, premiums and compensations by using average crop indicators in Latvia's countryside, when a systematic database of statistics of crop loss is not available.
Key words: crop risk, insurance service model.

Introduction

Agriculture is subjected to the impact of natural risks resulting in annual losses suffered by agricultural producers. The State, at its own expense, compensates agricultural producers for losses by means of the subsidies amounting to LVL 2.1 million on average. Since 2000 the insurance scheme for insuring risks in the crop-farming sector established by the Ministry of Agriculture has provided for the subsidy of persons involved in growing of crops in the amount of 50% of the insurance premium payments. However, there is no express demand for cereal crop insurance services, since losses are compensated for from the state funds without any obligation or financial input on the farmers' part. Moreover, there is no supply of cereal crop insurance services on the part of insurance companies.

According to the theory of insurance, agricultural risks typical of climatic conditions (systematic risks) are ranged in the group of risks between pure and speculative risks, which are difficult to insure. The essence of risk and individual attitude to risk have been defined by the following authors of risk management theory (Williams, Smith, Young, 1998; Jaunzems, Vasermanis, 2001; Graudiņa, 2002, 2003; Rejda, 2003; Willet, 1951; Tversky, Kahneman, 1992; Зубец, 2001; Machina, Schmeidler, 1992).

The necessity of the State involvement in the systematic risk management has been historically proven in the EU member states and other countries.

In the European Union, cereal crop risk management is effected on two levels: governmental emergency funds *(ad hoc)* and private insurance. The experience of the EU and other countries shows that public and private partnerships are possible on both levels and in different proportions as far as compensated losses are concerned. Procedures and requirements for the formation of emergency funds are set and defined on the European Union level.

This paper is based on monographs of agricultural risk insurance specialists and the EU documents on agricultural risk insurance, such as Commission Regulations (EC) No. 1/2004, and No. 1857/2006 and amendments to the Commission Regulation (EC) No. 70/2001 as well as on the research summarizing the experience of other countries

(Ray, 1998; Meuwissen, Huirne, Hardaker, Black, Hanf, Skees, 1999; Williams, Smith, Young, 1998; Skipper, 1998; Harrington, Niehaus, 2003; Rejda, 2003; Graudiņa, Jansons, 2006; Manitoba Crop Insurance..., 2005). The results of extensive research regarding agricultural risks and possibilities for their management have been recently published in Latvia (Pelāne, 2001; Šķeptere, 2003; Ercmane, 2003, 2004; Arhipova, Arhipovs, 2005; Merkurjevs, Bardačenko, Arhipova, Rudusa, 2004; Rivža, Špoģis, 2005; Turka, Mihejeva, Bankina, Bimšteina, 2005; Špoģis, Radžele, Jance, 2005; Bardačenko, Merkurjevs, Rudusa, Solomenikova, 2005; Špoģis, Dobele, 2005; Rivža, Rivža, Šantere, 2007; Ruža, Solomenikova, Merkurjevs, 2007). However, these publications do not contain methodological or other solutions for agricultural risks and their insurance.

An important factor of the relevancy of the theme is the necessity of a special original model for the crop risk insurance service, defining the methods for calculating coverage, premiums and compensations by using average crop indicators in Latvia's agriculture, when a systematic database of statistics of crop loss is not available.

Novelty of research: model of insurance service for the needs of Latvia cereal crop insurance development when a systematic database of statistics of crop loss is not available.

The research methods envisaged for solving the set tasks: the monographic descriptive method as well as the methods of analysis and synthesis are widely used in the paper to study the problem elements and synthesize coherencies; scientific induction method is used for summarizing individual facts in general statements and coherencies; deduction method is used for theoretical explanations and logical synthesis of the empirical study; the dynamic analysis method, data grouping method, constructive calculation method and statistical-graphical method are used for the analysis of statistical data; in the event that statistically significant data regarding the insurance product creation process are not available, actuarial mathematics elements are applied, using the insurance premium calculation method of the US Federal Crop Insurance Corporation (FCIC):

1) the size of the insurance coverage in cereal crop insurance is calculated:

$$\text{Insurance coverage} = \text{Crop}_{avg.} \times \text{Price, LVL t}^{-1}, \quad (1)$$

where (Ray, 1998; Manitoba crop insurance ..., 2005)

$\text{Crop}_{avg.}$ – the average cereal crop yield in 2000–2004 in the country, according to categories, t ha^{-1};

Price – the assumed average cereal price LVL 66.90 t^{-1} in the country in total and according to categories; it is constant in all examples offered LVL;

2) the expected value is calculated using the folloving formula (Pettere, Voronova, 2004; Skipper, 1998):

$$EV = \sum_{i=1} p_i x_i , \quad (2)$$

where

p_i – probability of the occurrance of event "i";

x_i – amount of losses; in cereal crop insurance x_i – probability of any possible yield loss p_i;

3) actuary insurance premium should completely cover the potential loss (Pettere, Voronova, 2004; Skipper, 1998):

$$P = Z , \quad (3)$$

where

P – insurance premium;

Z – potential loss;

4) loss arrays x_i are created separately for each category and calculated using the formula (Ray, 1998):

$$x_i \begin{cases} \text{Actual Yield} - \text{Coverage, if } \langle\ 0, \\ 0, \text{ if } \rangle\ 0 \end{cases}, \quad (4)$$

where

x_i – potential loss;

5) the indicators of cereal crop yield loss calculated for every unit characterising risks are used when calculating the probability of the occurrence of yield loss p_i (Ray, 1998):

$$\text{Probability } p_i = \frac{N_{loss}}{N} , \quad (5)$$

where

N_{loss} – is the number of events when loss x_i occurs;

N – is the number of units characterising insured risks in all categories;

6) to calculate the actuarial premium per hectare for Category 1, we use the criterion of statistical indicator of "expected value":

$$EV = 0.024\ (\text{t ha}^{-1}) \times 66.9\ (\text{LVL t}^{-1}) \times 0.139 = 0.223\ (\text{LVL ha}^{-1}); \quad (6)$$

7) assuming that loss records are precise, we can calculate the actuary calculation using the following equation (Ray, 1998; Manitoba crop insurance..., 2005):

$$(\text{Average yield } (\text{t ha}^{-1}) \times 80\% - \text{Actual yield}) \times \text{Price} = \text{Compensation for loss}. \quad (7)$$

Results and Discussion

Insurance Market in Latvia between 1992 and 2006. In the mid 1990's, further stabilization of Latvia's insurance market was promoted due to the implementation of the European Union legal framework, thus improving the supervision and legislation system of the insurance market. In 1994, life insurance commercial activities were separated from non-life insurance commercial activities.

Article 12 of the Law "On Insurance Companies and Supervision" sets forth which types of insurance in Latvia issue 19 sector licences (Apdrošināšanas sabiedrību ..., 1998).

Cereal crop insurance product/service is included in the subdivision of movable property insurance of property insurance (Fig. 1). Agricultural risks, particularly grain cultivation risks, are a specific phenomenon in the group of risks. In the aggregate of risks, grain cultivation risks are placed between the "pure" risks, i.e., completely independent, mutually uncorrelated risks, such as those related to property insurance, vehicle insurance, health insurance and "speculative", i.e., systematic, dependent, mutually correlated risks, such as risks characteristic of the market of contracts on future financial transactions (Pettere, Voronova, 2004; Crop insurance ..., 2009).

Several objects of potential loss with risks pertaining thereto are characteristic of agricultural sector – risks typical of insurance object of loss of a private person: injuries, diseases, death, risks typical of property insurance object: fire, storm, flood, theft, burglary (Īpašuma apdrošināšanas ..., 2005; Homeowners Insurance, 2009). Risks typical of insurance object of loss of yield (crop yield and livestock): natural risks, damage by third persons, plant diseases (Lauksaimniecības risku …, 2002). Risks typical of insurance object of loss of price: fluctuations of sales prices, fluctuations of purchase prices. Risks typical of insurance object of institutional (political) loss: legislative changes in the country, legislative changes in the EU (priorities in agricultural policy).

Risks typical of insurance object of financial loss: changes in credit interest rates, loan or credit management, financial solvency (Jakušonoka, 2005; Risk Management Tools ..., 2001; Income Insurance ..., 1999).

The author of the paper analyses specific grain cultivation insurance risks.

Experience of cereal crop insurance in other countries and in Latvia. In the European Union, cereal crop risk management is effected on two levels: public/governmental – special funds compensating for loss (*ad hoc* payments) with the average annual amount of compensations paid being EUR 904.3 million. The risks most often compensated for are: drought, frost and flood. Private insurance where the risks most often compensated for are as follows: hail and fire, with the average total amount of compensations paid being EUR 1061.0 million: insurance premiums are subsidised by the State.

Every EU country has risk management systems of governmental level as well as risk management systems of private insurance, which are established in each country depending on economic or historical traditions of agricultural risk insurance, such insurance against hail or fire risks, and compensation for loss is defined by the law.

1. In Italy, Spain, Austria, Portugal, Greece and Sweden, the government does not compensate for loss from special public funds if a relevant insurance service is available for the risk having caused the loss. In other EU countries, including Latvia, the law does not provide for restrictions regarding compensation

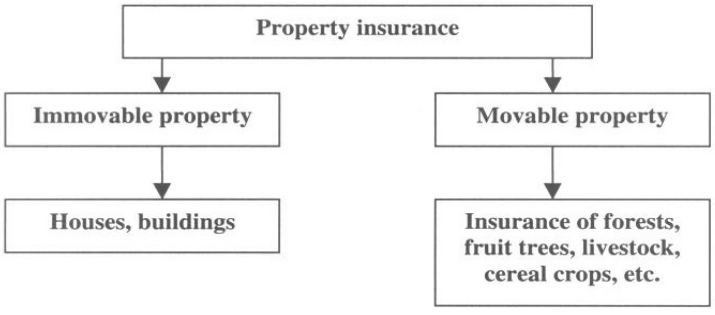

Fig. 1. Place of cereal crop insurance product/service in the package of non-life insurance services.

for loss.The largest compensations for loss from special public funds are in France (1996–2005), with compensations from public funds amounting to EUR 155.6 million per year. Only EUR 5.0 million comes from private insurance as compensation for loss in grain cultivation. In Spain (2000–2005), EUR 3.7 million on average come from public funds as compensations per year, and EUR 388.3 million on average come from private insurance, where the State subsidises 41% of insurance premiums. In Latvia (2000–2005), annual compensations for loss in grain cultivation coming from special public funds amount to EUR 3.2 million on average. The amount of compensations for loss in private insurance is not specified. The government of Latvia subsidises 50% of insurance premiums (Agricultural Insurance Schemes, 2006; Risk Management Tools ..., 2001; Meuwissen et al., 1999).

2. When the government is involved in support of private insurance services, private insurance offers coverage not only for hail and fire risks, but also for other agricultural risks related to climatic factors. Spanish private insurance, in close cooperation with the government of Spain and farmer's union, offers insurance coverage for virtually any possible agricultural risk related to climate. In Austria, France, Italy and Luxembourg, private insurance of grain cultivation, in collaboration with the government, offers insurance coverage not only for hail risk, but also for other climatic risks with the exception of drought risk.

In Bulgaria, Poland, the Czech Republic, Hungary, Portugal, Slovakia, Slovenia, and Sweden, private insurance offers insurance of hail risk in grain cultivation as well as insurance coverage of other risks depending on the insurance policy. In Belgium, Germany, the Netherlands and England, private insurance offers insurance of hail risk. The governments are not involved in subsidisation of insurance premiums (Agricultural Insurance Schemes, 2006; Risk Management Tools ..., 2001).

3. Insurance premium rates in the EU market range from 1% in England to 6-8% in Spain, Portugal and Italy. The main factors affecting rate range in the EU: risk frequency in time and space, insured risks (hail, drought) and their number in one policy, crop sensitivity to natural risks, deductible amount, number of insured households,

4. Deductible amount in insurance in the EU market ranges from 0% to 40% or more. Factors affecting the deductible amount: the bigger risk frequency in time and space, the higher deductible %, may appear as an individual approach to each separate farming household – the higher the deductible amount, the lower the insurance premium, new insurance product – bigger deductible amount (Agricultural Insurance Schemes, 2006; Risk Management Tools …, 2001).

On 25 April 2002, on behalf of the European Community, the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments there under the Council Decision (2002/358/EC) was passed concerning the approval. This attention should be brought to the so-called ''green box'', which describes the United Nations guidelines regarding subsidies for agriculture (Padomes 2002. gada 25. aprīļa lēmums (2002/358/EK) ..., 2006).

In the ''Communication from the Commission to the Council on risk and crisis management in agriculture'', European Community Commission (2005) suggests that the potential of three options should be assessed, from the point of view of individually or jointly, completely or partially replacing Community and Member States' *ad hoc* emergency measures (Komisijas paziņojums Padomei ..., 2005): Option 1: Insurance against natural disasters – financial participation in farmers' premium payments. Insurance provides an alternative to public ex-post compensation payments for losses caused by natural disasters at the EU and national or regional level. Option 2: Mutual fund support. Mutual funds represent a way of sharing risk among groups of producers who want to take their own responsibility for risk management. Option 3: Providing basic coverage against income crises. A more general coverage against crises that result in severe income losses would allow existing safety net provisions to be further simplified and improves the balance between different agricultural sectors.

Apart from the aforementioned three options, the EU offers creating a public emergency fund in grain cultivation for the compensation of crop loss and fixed assets of agricultural production, where in addition to classical systematic risks also unfavourable weather conditions are the defined losses. For example, risks of frost, hail, ice, rain or drought are set equal to natural disasters as soon as the scope of damage has reached a specified threshold of normal production.

Commission Regulation (EC) No. 1857/2006 of 15 December 2006 on the application of Articles 87 and 88 of the EC Treaty to State aid for small and medium-sized enterprises active in the production of agricultural products and amending Regulation (EC) No 70/2001. The Regulation allows Member-States to award different kind of State aid without prior permission of the Commission (Komisijas Regula (EK) Nr. 1857/2006 …, 2007). The Community guidelines for state aid in the agriculture and forestry sector 2007 to 2013 (2006/C 319/01) (Kopienas pamatnostādnes ..., 2006).

The information defines the level of State responsibility in the agricultural sector on the whole, including primary producers:

1) Section V of the document discusses issues related to risk and crisis management;
2) the common minimum threshold of damages is 30% of normal production for all areas; farmers always cover part of the losses; therefore, when creating a service, deductible amount should be applied;
3) compensation is not applicable if there is no insurance.

The management of demand and supply of agricultural risk insurance service in grain cultivation in Latvia, similar to other world and the EU countries, is effected on two levels. Public insurance – compensation for loss related to agricultural risks from the national budget, with total compensations paid in the period between 2000 and 2005 amounting to LVL 12.3 million (Table 1). The risks most often compensated for are: drought, frost and flood (Koncepcija "Par lauksaimniecības …", 2006). Private insurance – where aid for agricultural risk insurance in the form of subsidies has been determined every year since 2000 (Table 2). The Cabinet defines the annual amount of state aid for each supported programme of agricultural subsidies within a month from the date of passing the annual law on the national budget. The Minister for Agriculture sets forth the procedure for receiving such aid (Lauksaimniecības un lauku …, 2004).

During these years, the State has compensated the farmers for 50-70% of the amount of premium determined by the insurance company. For example, premiums for crops have ranged from LVL 5 to LVL 10 ha^{-1}. The regulations on subsidies have not been changed essentially during these years. In 2005, the aid for farmers was set forth under the Cabinet Regulations No. 70 ''Regulations on State Aid for Agriculture in 2005 and the Procedure of Allocation'' which were issued pursuant to Parts 4 and 6, Section 5 of the Law ''On Agriculture and Rural Development'' (Noteikumi par valsts atbalstu …, 2005).

The concept ''On Agricultural Risk Management Policy in Latvia'' developed by the Ministry of Agriculture in 2007 offers the following solutions: variant 1: Aid only for private insurance premium payments, variant 2: Aid for private insurance premium payments and establishment of compensation funds, variant 3: State aid for loss caused by unfavourable climatic conditions and for insurance premium payments (Koncepcija ''Par lauksaimniecības risku …'', 2007).

These solutions reflect the potential administrative models; however, in order to create an actuarially reasonable insurance fund, it is necessary to define the following irrespective of the administrative model – the object of insurance and insurable

Table 1

Compensations for loss caused by climatic fluctuations paid from the state funds in Latvia between 2000 and 2005, LVL

Ref. No.	Compensations for loss caused by climatic fluctuations	2000	2001	2002	2003	2004	2005	Total
1	Loss caused by frost	0.63						0.63
2	Loss caused by floods		0.09					0.09
3	Loss caused by dryness			5.90				5.90
4	Loss caused by excessive rainfall				5.00			5.00
5	Damage due to frost					0.22		0.22
6	Loss of livestock due to midge bites and loss caused by floods						0.44	0.44
	Total:	0.63	0.093	5.90	5.00	0.22	0.44	12.28

Table 2

Number of households–recipients of insurance premium subsidies in grain cultivation and livestock breeding in Latvia between 2002 and 2005 (units)

Ref. No.	Number of recipients of subsidies	2002	2003	2004	2005
1	Grain cultivation	41	2	0	no data
2	Livestock breeding	no data	no data	no data	138

risks, insurance coverage and deductible, method of premium calculation if historical data are not available, loss record keeping system and method of claim calculation.

Model of insurance service for cereal crop yield. The choice of administration of the insurance scheme determines the nature of insurance, for instance, personal insurance, state insurance – public sector, combined insurance – private and public sectors.

The combined model of administrative insurance is the optimum choice for systematic risk management from both a theoretical and practical point of view. Communication between participants of the insurance scheme is formed (Fig. 2) (Collin, Hansson, 2000).

Insurance legal base determines the nature of insurance: optional personal insurance, mandatory service of optional insurance (such as *OCTA* – Mandatory insurance of civil liability of vehicle owners in Latvian insurance market), mandatory state level insurance, and mandatory municipal insurance.

Risk management capacity is affected by the number of units characterising risk – the bigger the number of units characterising risk (farming households), the bigger risk management capacity.

The following steps to be taken to ensure the biggest possible risk management capacity: to set forth by the law mandatory crop insurance service, to set administratively a long-term insurance contract for cereal crop insurance service, for example, for 5 years.

The risks affecting the potential loss of cereal crop yield: risks caused by natural disasters: drought, hot wind, excessive humidity, storms, frost, flood, earthquake, and landslide, other risks: plant diseases and pests, damage caused by animals, risks related to damage by third persons. The elements describing the administration of cereal crop insurance: property right to the land under crop (the owner's property, joint property or leased land is managed); classification of areas under cereal crop according to their productivity, flow data of cereal crop productivity in years: in households, in regions or in the whole country. The minimum period for summarizing data is five years; setting of economically sound insurance coverage; setting of insurance rate pursuant to the size of the loss ratio if actual loss indicators are available; if actual loss indicators are not available, the rate can be calculated pursuant to the indicators of cereal crop productivity, alignment methods for the potential consequences of moral hazards and asymmetrical market, such as deductible; cereal crop insurance compensation.

Setting stages of the insurance service, the basic administration element of cereal crop insurance:

1) insurance coverage assessment;
2) insurance rate calculation and insurance premium determination;
3) loss identification and compensation (Blends, 1995; Skipper, 1998).

Calculations of cereal crop insurance service are based on the data regarding the average cereal crop productivity in the country in total between 2000 and 2004. The data are classified into three relevant categories.

Category 1 characterises areas of the country with the lowest average cereal crop yield during the last five years against the total cereal crop yield indicator in the whole country (1.68 t ha^{-1}). Category 1 represents 467 80 households with the total area of 151 724 ha.

Category 2 characterises areas of the country with the medium-sized average cereal crop yield during the last five years against the total cereal crop yield indicator in the whole country (2.20 t ha^{-1}). Category 2 represents 4 735 households with the total area of 210 024 ha.

Category 3 characterises areas of the country with the highest average cereal crop yield during the last five years against the total cereal crop yield indicator in the whole country (3.16 t ha^{-1}). Category 3 represents 220 households with the total area of 74 900 ha (Lauku saimniecības Latvijā ..., 2005). In insurance, property insurance coverage and potential loss scope are defined before the occurrence of the insured risk. In case of cereal crop insurance, the potential loss and insurance coverage can be established only at the time of harvesting.

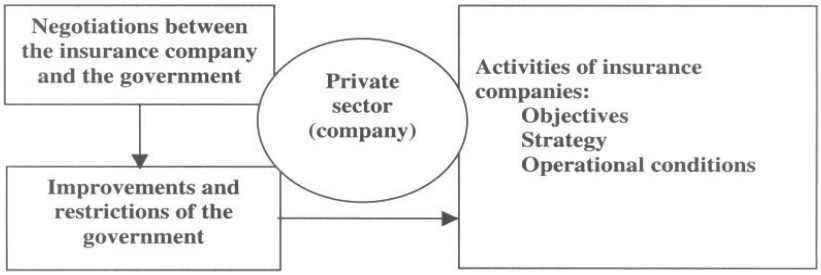

Fig. 2. Communication between the public and private sectors in creation of insurance schemes.

To reduce the impact of adverse selection and moral hazard on the insurance market, we will use the classical insurance mechanism for alignment of adverse selection and moral hazard: deductible where the amount of deduction is fixed, coinsurance where a set percentage is fixed. The size of the insurance coverage in cereal crop insurance is calculated depending on the indicators of the average cereal crop yield in a year, during a period of at least five years, unless significant loss of cereal crop yield has occurred within these five years (formula 1). Insurance coverage amount for instance, if insurance coverage is 100%, borders of categories differ by LVL 99.34 ha^{-1}; if insurance coverage is 90%, borders of categories differ by LVL 89.41 ha^{-1}; if insurance coverage is 80%, borders of categories differ by LVL 79.41 ha^{-1} (Table 3) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005).

The statistical equation of ''expected value'' formula (2), on which the insurance premium calculation is based, can be simplified according to the classical insurance theory stating that the actuary insurance premium should completely cover the potential loss formula (3).

We will use the formula (4) for estimation of the premium, calculating insurance compensations paid (potential loss) x_i and probability p_i, with which such losses may occur. Loss arrays x_i are created separately for each category and calculated using the formula (4).

To calculate potential loss x_i we calculate the average yield in the regions for the period of five years, observing the classification of the regions into categories, apply the calculated average yield to the relevant insurance coverage of 80%, 90% and 100%, observing the classification of the regions into categories (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons 2006; Ray, 1998). We calculate the average yield loss of each year, observing the classification of the regions into categories and coverage types. For example, flow data of the average yield of Category 1 for units characterising risks and the average cereal crop yield with the insurance coverage of 80% are 1.34 t ha^{-1}. We define the units characterising risks (regions) where the average cereal crop yield is lower than the set cereal crop yield, i.e., lower than 1.34 t ha^{-1}. The average level of cereal crop yield of units characterising risks of Category 1 is lower than the set cereal crop yield level, i.e., 1.34 t ha^{-1} in nine regions. Pursuant to these indicators, we establish the average scope of loss of the average cereal crop yield of Category 1, if the level of loss is below the average indicator for the loss 1.34 t ha^{-1} (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998). We calculate the potential average cereal crop loss x_i for insurance coverage of 80%, 90% and 100%, according to categories (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998).

The lowest cereal crop losses are for the units characterising risks of Category 3 with the insurance coverage of 80%. The highest cereal crop losses are

Table 3

Insurance coverage amount by categories if insurance coverage is 80%, 90%, and 100%

Category Ref. No	Average crop yield, t ha^{-1}	Insurance coverage 80%, LVL ha^{-1}	Insurance coverage 90%, LVL ha^{-1}	Insurance coverage 100%, LVL ha^{-1}
1	1.68	89.65	100.85	112.06
2	2.20	117.13	132.22	146.91
3	3.16	169.12	190.26	211.40

Table 4

Average dynamic cereal crop yield loss by categories for all units characterizing risks in Latvia between 2000 and 2004 with the insurance coverage of 80%, 90%, and 100% (t ha^{-1})

Category	Average crop yield	80% coverage	Crop loss	90% coverage	Crop loss	100% coverage	Crop loss
Category 1	1.68	1.64	0.024	1.51	0.055	1.68	0.104
Category 2	2.20	1.75	0.007	1.98	0.042	2.20	0.142
Category 3	3.16	2.53	0.000	2.84	0.010	3.16	0.113

for the units characterising risks of Category 2 with insurance coverage of 100%. We create a joint base of indicators of the average dynamic cereal crop yield loss according to categories for all units characterising risks with the insurance coverage of 80%, 90%, 100% (t ha^{-1}) (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998).

The indicators of cereal crop yield loss calculated for every unit characterising risks (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998) are used when calculating the probability of the occurrence of yield loss p_i (formula 5).

For each category we calculate the average loss from the probability of loss. To determine the average arithmetic value for the yield every year, the annual assessment of probability of loss should be made, for instance: value 0.1385 is the assessment of probability where in 13.85% of cases a loss of 0.024 t ha^{-1} occurs.

Loss for Category 1 (the first group of households) with the average cereal crop yield of 1.68 t ha^{-1} is 0.024 t ha^{-1}. To calculate the actuarial premium per hectare for Category 1, we use the criterion of statistical indicator of ''expected value'' (formula 6). It means that the actuarial premium of cereal crop yield for Category 1 with the insurance coverage of 80% is LVL 0.22 ha^{-1} (Table 5) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998). For the actuarial cereal crop insurance premium according to categories with the insurance coverage of 80%, 90%, 100% calculated for three categories.

Applying the insurance coverage of 80%, 90% and 100% for the calculations of cereal crop insurance premiums, we obtain the following results: cereal crop insurance premium with the insurance coverage of 80% for Category 1 is LVL 0.233 ha^{-1}, and cereal crop insurance premium with the insurance coverage of 100% is LVL 2.783 ha^{-1}. The amount of loss according to categories (Fig. 3) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998) varies depending on the insurance coverage and average indicators of cereal crop yield. We may conclude that Category 2 is the category most exposed to risk, i.e., farming households with medium-sized areas under cereal

Table 5

Actuarial cereal crop insurance premium, LVL ha^{-1}, by categories with the insurance coverage of 80%, 90%, and 100%

Insurance coverage according to categories	Actuarial cereal crop insurance premium, LVL ha^{-1}, with insurance coverage of 80%	Actuarial cereal crop insurance premium, LVL ha^{-1}, with insurance coverage of 90%	Actuarial cereal crop insurance premium, LVL ha^{-1}, with insurance coverage of 100%
Category 1	0.223	0.849	2.783
Category 2	0.026	0.868	6.222
Category 3	0.000	0.134	3.779
Actuarial cereal crop insurance premium, LVL ha^{-1}	0.201	0.843	3.104

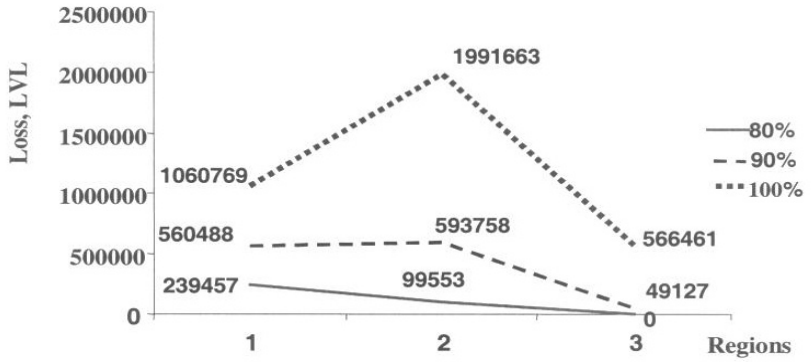

Fig. 3. Average cereal crop yield loss in LVL by categories in Latvia between 2000 and 2004 with the insurance coverage of 80%, 90%, and 100%.

Table 6

Average indicators of compensation for cereal crop yield loss in Latvia between 2000 and 2004, LVL ha^{-1}

Insurance coverage according to categories	Insurance compensation		
	80% coverage	90% coverage	100% coverage
Category 1	8.69	10.09	11.20
Category 2	11.77	13.21	14.69
Category 3	16.93	19.03	21.14
Average insurance compensation for yield loss	12.46	14.11	15.68

crop and medium-sized cereal crop productivity, as cereal crop productivity is affected not only by climate conditions, but also intellectual, social, economic, disposition, professional, commercial, financial, crediting, investment and other risks. Potentially, it is a group of producers who would be most willing to purchase insurance. If the insurance coverage of cereal crop of the cereal producers of this category is 90%, the actuarial cereal crop insurance premium is LVL 0.868 ha^{-1} (Table 5) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998). The result is dramatically different if the insurance coverage is 100%. In this case, the actuarial insurance premium for Category 2 is LVL 6.222 ha^{-1}. When creating an insurance service, it is necessary to offer such a service with various amount of insurance coverage: 100%, 95%, 90%, 85%, 80% depending on the level of cereal crop yield. Pursuant to the calculated example, the most profitable insurance coverage is 90%, where the actuarial insurance premium for cereal crop is:

– Category 1: LVL 0.849 ha^{-1};
– Category 2: LVL 0.868 ha^{-1};
– Category 3: LVL 0.134 ha^{-1}.

The dramatic differences of the calculated insurance premiums according to categories can be mainly explained by the fact that 10% of crop loss occurs much rarer in households with high cereal crop productivity than in households where the average cereal crop productivity is lower.

The actuarial insurance premium for cereal crop of Category 3 with the coverage of 100% is 3.779 which is 28 times bigger (Table 5) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998) than the actuarial insurance premium for cereal crop with the insurance coverage of 90%.

The most difficult task is to determine the actual loss, as there exist many factors affecting yield loss in nature that are not discussed and analysed in the present paper. Assuming that loss records are precise, we can calculate the actual calculation using the following equation (formula 7). Let us assume that the actual cereal crop yield is by 10% smaller than the average cereal crop yield in all categories with the insurance coverage of 80% is

$$\left[1.34\ (\text{t ha}^{-1}) - 1.21\ (\text{t ha}^{-1})\right] \times 66.9\ (\text{LVL t}^{-1}) = 0.13\ (\text{t ha}^{-1}) \times 66.9\ (\text{LVL t}^{-1}) = 8.69\ \text{LVL ha}^{-1}.$$

In this case the scope of compensation for cereal crop yield loss within Category 1 is equal to LVL 8.69 ha^{-1}, if insurance coverage is 80% (Table 6) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998).

Conclusions

1. Latvia's insurance market is developing pursuant to EU legislation and according to historical experience and regularities of EU Member States and other countries. The general development trends of the insurance market are positive – the insurance market size is increasing.
2. In the European Union, cereal crop risk management is effected on two levels: governmental emergency funds *(ad hoc)* and private insurance. The experience of the EU and other countries shows that the public and private partnerships is possible on both levels and in different proportions as far as compensated losses are concerned.
3. In Latvia, risk management related to cereal crop yield is effected on two levels: on public level by compensating for loss from the national budget and subsidizing insurance premiums and on the level of the so far underdeveloped private insurance.
4. Mathematical model of crop insurance service has been developed establishing:
   1) method of calculating the insurance coverage;
   2) method of calculating the insurance premium;

3) method of calculating the insurance compensation in a situation in Latvia's countryside when a systematic database of statistics of crop loss is not available.

The amount of loss according to categories varies depending on the insurance coverage and average indicators of cereal crop yield. The optimum level of deductible is 10%, with the insurance coverage of 90%, where the actuarial insurance premium for cereal crop is:

1) Category 1: LVL 0.849 ha^{-1};
2) Category 2: LVL 0.868 ha^{-1};
3) Category 3: LVL 0.134 ha^{-1}.

The actuarial insurance premium for cereal crop of Category 3 with the coverage of 100% is 3.779, which is 28 times bigger than the actuarial insurance premium for cereal crop with the insurance coverage of 90%. Representatives of Category 2 are most exposed to risk. This is a group of producers, who would be most willing to purchase insurance. If the insurance coverage of cereal crop of the cereal producers of this category is 90%, the actuarial cereal crop insurance premium is 0.868 LVL ha^{-1}. The result is dramatically different if the insurance coverage is 100%. In this case, the actuarial insurance premium for Category 2 is 6.222 LVL ha^{-1}.

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Anotācija

Lauksaimnieciskā ražošana pakļauta dabas risku ietekmei, kā rezultātā katru gadu lauksaimniecības produkcijas ražotāji cieš zaudējumus. Valsts no saviem līdzekļiem lauksaimniecības produkcijas ražotājiem subsīdijās atlīdzina zaudējumus vidēji gadā 2.1 milj. latu apmērā. Kopš 2000. gada valsts Zemkopības ministrijas iedibinātās augkopības nozaru riska apdrošināšanas shēmas ietvaros subsidē personas, kuras nodarbojas ar kultūraugu audzēšanu, 50% apmērā no apdrošināšanas prēmijas izmaksām. Taču nav izteikta pieprasījuma pēc graudaugu apdrošināšanas pakalpojuma, jo zaudējumi tiek kompensēti no valsts līdzekļiem bez jebkādām saistībām un iemaksām no zemnieku puses un nav arī graudaugu sējumu apdrošināšanas pakalpojuma piedāvājuma no apdrošināšanas sabiedrību puses. Lauksaimnieciskās ražošanas (sistemātisko) risku vadībā valsts līdzdalības nepieciešamība vēsturiski apstiprinājusies gan ES dalībvalstīs, gan arī citās valstīs. Eiropas Savienībā graudaugu ražas risku vadība notiek divos līmeņos: valdības ārkārtas fondi (*ad hoc*) un privātā apdrošināšana. ES un citu valstu pieredze rāda, ka valsts un privātā sadarbība iespējama abos līmeņos un dažādās proporcijās attiecībā uz atlīdzinātiem zaudējumiem. Eiropas Savienības līmenī ir noteiktas konsekvences un izteiktas prasības valdības ārkārtas fondu veidošanai.

Lauksaimniecības risku apdrošināšanas problēmu risinājumus piedāvā Eiropas Komisijas regulas. Izmantoti arī Latvijas un citu valstu pēdējo gadu lauksaimniecības risku vadības pieredzes pētījumu publicēto materiālu rezultāti. Taču šajās publikācijās nav atrodami lauksaimniecības risku un to apdrošināšanas metodiskie vai citādi risinājumi. Pētījuma aktualitāte saistīta ar to, ka nav pieejama ražas zaudējumu sistemātiska statistikas datu bāze, līdz ar to ir izveidots nepieciešamais jaunais modelis ražas risku apdrošināšanas pakalpojumam.