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CROP INSURANCE IN TRANSITION

A Qualitative and Quantitative Assessment of Insurance Products*

(Preliminary Results)

RAUSHAN BOKUSHEVA

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STIFTUNG DES ÖFFENTLICHEN RECHTS

Theodor-Lieser-Straße 2, D-06120 Halle (Saale), Germany
Phone: +49-345-2928 110
Fax: +49-345-2928 199
E-mail: iamo@iamo.uni-halle.de
Internet: http://www.iamo.de

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Dr. Raushan Bokusheva is a senior research associate at the Institute of Agricultural Development in Central and Eastern Europe (IAMO), Division: Structural Development of Farms and Rural Areas, in Halle, Germany. Her research mainly focuses on risk assessment and risk management in agriculture.

Mailing address: Institute of Agricultural Development in Central and Eastern Europe (IAMO)
Theodor-Lieser-Straße 2
D-06120 Halle/Saale
Germany

Phone: +49-345-2928 134
Fax: +49-345-2928 399
E-mail: bokusheva@iamo.de
Internet: http://www.iamo.de

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ABSTRACT

This discussion paper considers insurance as a possible instrument of farm income stabilization and compares several crop insurance products with respect to their applicability in a transition economy using the case of Kazakhstan. The analysis is based on a qualitative evaluation as well a quantitative assessment of selected insurance products. The qualitative analysis reviews the available literature on the topic. The quantitative assessment completes the comparison introducing the findings of a numerical analysis of farm and weather data.

JEL: G22, Q14, D82
Keywords: Risk, Insurance schemes, Agriculture.

ZUSAMMENFASSUNG

Dieses Diskussionspapier behandelt Ertragausfallversicherungen als ein potenzielles Instrument der Stabilisierung der Einkommen landwirtschaftlicher Betriebe. Dabei werden einige Versicherungsprodukte auf ihre Anwendbarkeit in einem Transformationsland (am Beispiel vom Kasachstan) komparativ analysiert. Die Analyse wurde auf der Basis der theoretischen Beiträge zur Entwicklung des Versicherungsmarktes als auch der Ergebnisse einer numerischen Analyse der Wetter- und Betriebsdaten durchgeführt.

JEL: G22, Q14, D82
Schlüsselwörter: Risiko, Versicherungsprodukte, Landwirtschaft.

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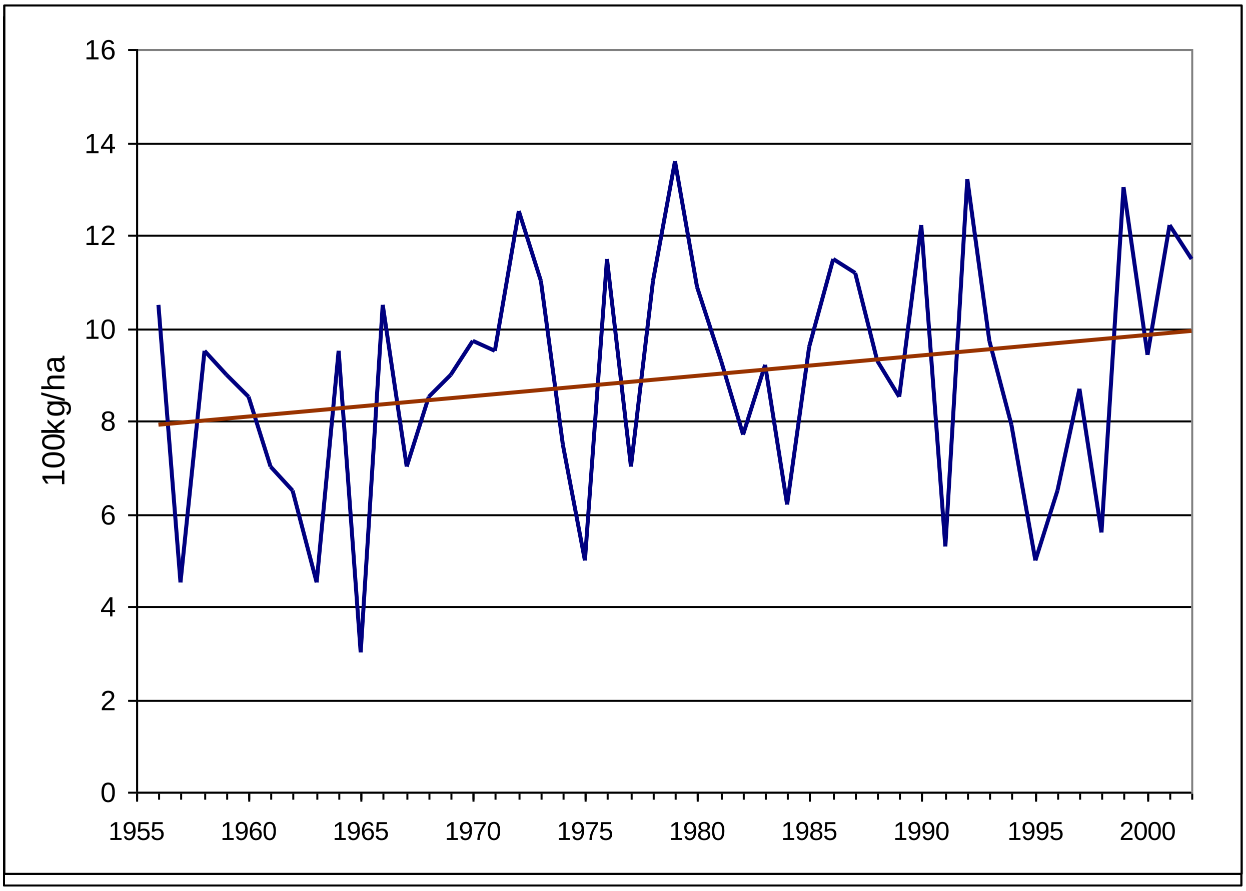
1 INTRODUCTION

Governmental interventions were an important part of agricultural policies in socialist countries. Unfortunately, these government actions often neglected conditions for economically-sustainable farming. In the former Soviet Union, primarily output-oriented agricultural policies extended agricultural production even to marginal production areas, and thus created a significant misallocation of resources.

Under the Virgin Land policy, 41.8 Million hectares (ha) were opened up for grain farming in the Soviet Union. In Kazakhstan, crop farming was extended from 6.7 Million to 21.9 Million ha from 1954 to 1964. Thereby, in addition to the areas suitable for crop production, much virgin land was ploughed in areas with poor soil quality and weather conditions which were unfavorable for crop production. Prior to 1991, the crop farming in Kazakhstan was extended to 35.3 Million ha. In the Soviet times, production risks due to natural hazards and catastrophes did not affect farmers' incomes since their production losses were compensated by the government. Nowadays agricultural enterprises face high production risks and inevitably have to adapt to natural conditions. During the last 10 years, a drastic reduction of sown area has been observable. According to an official statistic, sown area was reduced from 35.2 to 17.8 ha in the same period (see Appendix A). The steepest decline of sown area was evident from 1996 to 1998, when most parts of the country experienced drought, and as a result many farm businesses were forced into bankruptcy (Gray, 2000). Territorially, the sharpest decline occurred in the regions which, due to their agro-climatic conditions, have a higher exposure to natural risks. In 2002, less than 33 percent of the total area sown in 1990 was being cultivated. As a consequence of different rates of reductions in the area cultivated in individual regions, regional structures of cultivated area underwent substantial changes as well. Currently, the most productive areas in Northern Kazakhstan cover about 63 percent of whole sown area. 11.5 percent of sown area is in the primarily irrigated production area in Southern Kazakhstan. These two regions have increased their shareof production. Regions with many marginal production areas account for a little more than 25 percent of whole sown areas in the country. Though this development illustrates that much land where sustainable production is not achievable is taken out of cultivation, Kazakhstan is still confronted with the problem of high vulnerability of farm incomes with regard to unfavorable weather and production conditions in vast areas of the country.

The extension of wheat production to areas with a high exposure to natural hazards was supposedly accompanied by an increase of a systemic, i.e., non-diversifiable, component in production risk. Natural hazards such as drought and extremely high temperatures typically affect a large number of farms over widespread areas in Kazakhstan simultaneously. This serves as an explanation for a high variation in the level of the national annual yields (Figure 1).

Figure 1: Grain Yields in Kazakhstan (1955-2002)



Source: Rostankowski (1979), Petrick (2001), Statistical Yearbook of Kazakhstan (2003).

The option of reducing production risks by applying on-farm risk management tools can be used only to a limited extent in a transition economy. Hard budget constraints, the lack of working machinery, and scarce working capital result in even less favorable conditions for crop production when compared to previous years (Petrick, 2001). Like many of the former Soviet Republics, Kazakhstan preserved compulsory agricultural insurance in order to help farmers manage their risks. Up until 1997, insurance services for agriculture were provided by the state insurance company KazGosstrakh. In spite of the legal requirements for all legal farm entities to take risk insurance for all operations, the market for insurance remained under-developed and few farms were insured. Those, which did buy insurance usually did so only to meet formal requirements for other purposes such as access to credit (Gray, 2000). In 1998, the Government established KazAgroPolis in order to develop a public-sector supplier of crop insurance. However, its operations remained very limited and, according to the National Bank of Kazakhstan (The National Bank of Kazakhstan, 2002) after its last restructuring in 2001, KazAgroPolis lost its licence for providing any type of insurance services.

In 2003, Kazakhstan's government prepared a draft law on compulsory insurance in crop production. According to this document, private insurance companies were allowed to provide crop insurance, and the government was obliged to pay 50 percent of indemnity in case of crop failure. A survey of key actors[1] conducted in autumn 2003 showed that the insurance scheme proposed by the government contained many serious shortcomings and was attractive neither for insurance companies nor farmers. However, the Parliament passed the law in March 2004 to provide an insurance option to farmers. Nevertheless, no farm was insured in 2004, as many issues of the institutional framework with respect to the introduction of the new insurance scheme remain not solved.

There are many critical issues which explain the failure to develop a crop insurance in Kazakhstan. But, most of them could be separated into two major groups: neglecting of general insurance requirements and specific issues with regard to transition process. Therefore the motivation of this study is to assess several insurance products with respect to their potential to be adequate to both general insurance aspects and particular problems of transition.

This study is part of a research project on the analysis of requirements for the development of an economically-sustainable crop insurance in a transition country using the case of Kazakhstan. Particularly, the objective of this study is a comparison of several insurance schemes with respect to their ability to serve as an acceptable instrument of farm income stabilization in transition. The assessment is based on both the literature on the issue and the preliminary results of a numerical analysis of farm and weather data. The study uses extensively the results and data from a farm survey conducted in the framework of the project (Heidelbach et al., 2004). The author thanks Olaf Heidelbach for his helpful assistance in preparing chapters 2 and 3 of this discussion paper. A special word of thanks goes to the project associates Bota Borina and Darina Ostrikova who were extensively involved in the data collection. The author is also grateful for advice provided with regard to drought index application by Alexej Ivannikov from Agrarian University in Astana, Ludmila Chuntonova from Kazhydromet (Kazakh Hydro-meteorological Agency) and Irina Yesserkepova from Kazakh Research Institute for Environmental Monitoring and Climate.

The paper is organized as follows: Section 2 gives a short overview and systematization of the most current and widespread insurance products. Section 3 presents a discussion of the comparative advantages of two well-established and two relatively new crop insurance schemes. This discussion is followed by a quantitative assessment of the potential for introducing parametric (index) insurance in Kazakhstan. Conclusions are drawn in the final section.

[1] The survey was conducted in the form of the structured interviews with members of Parliament, representatives of insurance companies, farmers' unions, regional administrations and insurance and agricultural experts. 21 persons were interviewed in September-October 2003.

2 SHORT OVERVIEW OF INSURANCE PRODUCTS

Crop insurance is used in many countries and a variety of crop insurance products are offered worldwide[2]. Several relatively new insurance schemes are being investigated to respond to special needs and issues on pilot-basis. The diversity of insurance products makes it difficult to draw a clear distinction between them. Therefore, before starting an analysis of different insurance schemes, the most important insurance products will be presented and systemized to provide an understandable overview (Table 1).

Generally, one can distinguish between all-risk, multiple risk and particular risk insurance. Two additional important groups of insurance schemes should be considered separately: parametric and catastrophic insurance. At the same time, two mechanisms of crop insurance could be distinguished. The first mechanism is based on the actual production history (APH) of the farm. APH provides the base for different calculations using the insured's historical yield records. Another mechanism of insurance is the so-called parametric or index-based insurance, which uses weather or area-yield indexes for pricing insurance contracts. Thereby, insurance payoffs are subject to the occurrence of a special weather event, which can be described by a weather-based index (Skees, 1999). In case of area-yield insurance, average area yield "triggers" an indemnity payment which is equal to the difference, if positive, between the annual area yield and some predetermined critical yield (Miranda, 1991).

The next distinction can be made regarding crop insurance products is the particular objective they are designed for. Primarily, one can distinguish between yield-only (or crop), revenue and income insurance schemes. In contrast to crop insurance, revenue and income insurance schemes provide protection against both production and price risks.

Aside from this ordinary distinction, crop insurance products may be modified with regard to the following issues:

- Participation (compulsory versus voluntary participation),
- Contract duration (multi-year versus single year insurance contracts),
- Monitoring mechanism and technique,
- Re-insurance regulations,
- Deductibles, and
- Prices, which are used to calculate indemnity.

An important distinction to be drawn pertains to the organizational form of insurance provision. In this regard, several options exist: private and state-subsidized private insurance, insurance by the state and insurance on a mutual basis.

[2] Most of them, however, were introduced in the USA, where crop insurance has a long history as an instrument of farmers' income stabilization.

Table 1 Main crop insurance products

Type of Insurance	*Based On*	*Examples of Existing Insurance Products*
All-risk insurance Multi-peril insurance Particular risk insurance	Actual Production History (APH)	Whole-Farm Income Insurance (NISA) Whole-Farm Gross Revenue Insurance (FGRI) Commodity Gross Revenue Insurance (CGRI) Income Protection (IP) Crop Revenue Coverage (CRC) Revenue Assurance (RA)
Parametric Insurance	Area-yield Index Weather Index	Group Risk Plan (GRP) Group Risk Income Protection (GRIP) Rainfall-Based Index Insurance (PBII)
Catastrophic Insurance	(APH)	Catastrophic Coverage Level (CAT)

Source: Bokusheva and Heidelbach, 2003

This short overview shows that, although there exists a variety of insurance products at the moment, most of them bear a resemblance to each other and are based on the same features or functioning principles. In the following, the paper discusses four insurance products with regard to their capacity and applicability under transition circumstances. Particularly, the discussion concerns two well-known products, multi-peril yield insurance and farm gross revenue insurance, as well as two relatively recently-developed insurance schemes, area yield crop insurance and weather-based index insurance. All four insurance schemes are analyzed with regard to their comparative advantages regarding general issues as well as aspects that are especially important under the conditions of a transition country.

3 QUALITATIVE COMPARISON OF INSURANCE PRODUCTS

In light of the complexity of challenges and many interdependencies between individual aspects of insurance market development, it is important to set up criteria which can help to compare individual insurance products. Though it is not easy to draw a clear division between individual aspects, the following assessment features were considered in this study:

- Insurability,
- Incentives for farmers to buy insurance,
- Incentives for private insurance to provide crop insurance,
- Possible effects on productivity and production patterns,
- Feasibility (applicability),

- Financial viability of insurance scheme.

In addition the assessment considers several issues which are especially important in the transition context. The most important follow:

- underdevelopment of financial markets,
- possible presence of marginal production areas, and hence a higher exposure to systemic risks, which can seriously affect the development of financially-viable crop insurance,
- large differences in farm productivity that can induce adverse selection,
- information deficiency in view of complex farm restructuring and changes in production patterns,
- underdeveloped market infrastructure, which lowers the profitability of farming,
- low liquidity of farms, which can hinder their participation in crop insurance schemes,
- many farmers had bad experiences with insurance during the Soviet era. This makes them cautious and less interested in insurance,
- low attractiveness of involvement in agriculture on the side of private insurance, first of all due to high risk and transaction costs. However, not least due to low profitability of farming in general.

A short presentation of the particular advantages and disadvantages of the considered crop insurance schemes with respect to the selected criteria is provided in Appendix B. Several issues, however, will be more precisely examined in the following.

3.1 Insurability

Past experience strongly suggests that not all risks are insurable. In agriculture in particular, many crop insurance programs fail to operate on an actuarially-sound basis. In theory, there are two attitudes towards the question of risk insurability. Among others, Berliner (1982) underlines the requirement that it must be possible to make reliable estimates of the relevant probabilities from statistical observations. The implication is that a risk is insurable only if it can apply the law of large numbers. In the insurance sector, risk is classified as insurable as long as actuarially-sound premiums are charged. Actuarially-sound premiums have to accurately reflect the risks involved. However, actuarially-sound premiums can often be established only at a very high premium or cannot be achieved at all (Meuwissen et al., 1999). With respect to the realization of the law of large numbers, a serious difference may be constituted only regarding two general options: compulsory and voluntary insurance. In principle, every insurance product considered in this analysis can be provided in one of both ways. As mentioned before, many socialist countries tried to realize insurability by introducing compulsory insurance. Farms had to pay for insurance without any decision option (even if they did not need one). Moreover, the premiums established by the state insurance companies were not correlated with the actual risks involved, as premium rates were distinguished only according to relatively large territorial units (Zadkov, 1997; Pye, 2000). Such developments induced negative experiences with insurance in the cases of successful enterprises and the free-riding behavior of loss-makers. The process of privatization in Kazakh agriculture has had a significant impact on the importance of risk for agricultural producers. Nowadays, farmers inevitably have to adapt their production to natural production conditions (Petrick, 2001). Thereby, they are looking for appropriate instruments of risk mitigation. As the results of a farm survey[3] show, 64.4 percent of the respondents would like to be insured. However, only 43.8 percent of this number believes that crop insurance should be compulsory in Kazakhstan (Heidelbach, Bokusheva and Kussayinov, 2004). A compulsory insurance scheme usually undermines the farmer's decision-making autonomy and hence affects activity of individual farmers. In such circumstances, farms are forced to employ risk-management instruments which may not provide the best solution to the farm's problems, or must even pay for services which they do not need. This makes compulsory insurance rather different from transition goals, since it violates free decision-making and, respectively, production factors allocation. Additionally, a compulsory insurance scheme is usually heavily regulative, which prevents insurance companies from setting actuarially fair premiums.

In addition, to realization of the law of large numbers, the literature specifies two further aspects that have an effect on insurability: systemic risk and asymmetric information. In assessing the insurability of risks in agriculture, Miranda and Glauber (1997) identify both as basic conditions for risk insurability: first, the risks should be nearly stochastically independent across insured individuals; second, the insurer and the insured should have very nearly symmetric information regarding the probability distribution of the underlying risk.

Contrary to automobile or fire risks, which tend to be independent, the crop-yield risk exhibits a substantial degree of correlation across space (Miranda and Glauber, 1997). As stated before, crop losses in Kazakhstan are often driven by natural disasters, which simultaneously affect a large number of farms over a widespread area. Drought and extremely high temperatures are the main natural hazards that induce systemic yield losses of grain producers in most important production areas there. In light of the high specialization scale of Kazakh agriculture, where grain currently makes up 80 percent of gross agricultural output and covers 79 percent of the sown area in Kazakhstan (Statistical Yearbook Kazakhstan, 2003), the problem of systemic risk can be especially serious. The concentration of grain production in the northern regions in Kazakhstan with similar climatic conditions makes this issue even more severe (Appendix C demonstrates the correlation of regional grain yields). In this context, considering the capacity of an insurance scheme to treat systemic risk is of great importance in comparing alternative insurance products. As multi-peril yield and revenue insurance could not provide a solution for systemic risk, innovative insurance schemes have been

[3] This farm survey was implemented in October-November 2003 and May-June 2004. 73 farmers and managers of agricultural enterprises were interviewed in the different parts of the country during this time (Heidelbach et al., 2004).

considered in several countries. Currently, area-yield insurance and weather-based insurance are regarded as the most appropriate alternatives to conventional insurance products. However, the high correlation among individual farm-level yields may force insurers to charge a high risk premium which makes insurance unattractive (Mahul, 2001). The problem in this context is that risk pooling is difficult to achieve between those who are exposed to the same type of systemic risk. Hence, to manage the problem of systemic risk in agriculture, risk pooling must be extended to other economic sectors, for example, by introducing financial market products such as weather derivatives. At the same time, considering the case of a transition country requires much attention to be paid to the economic viability of agricultural production in individual regions. If long-term farm profitability is not achievable due to unfavorable weather and production conditions in a region, risk pooling would not be an appropriate mechanism of farm income stabilization, since it would imply an income redistribution from profitable to unprofitable farms and, respectively, from more productive to less productive sectors of the economy.

Asymmetric information manifests itself primarily in terms of adverse selection and moral hazard. Adverse selection in insurance markets is caused by the inability of the insurer to accurately rate the risk of loss of individuals who purchase insurance. Moral hazard is a result of hidden actions of the insured, which increase the risk of loss of the insurer. Theoretical and empirical studies (Akerlof, 1970; Rothschild and Stiglitz, 1976; Makki and Somwaru, 2001) have shown that adverse selection reduces the consumption of insurance by low-risk individuals or businesses, and results in the transfer of income from low-risk to high-risk insured. Miyazaki (1977) and Wilson (1977) demonstrate that, when it is impossible or highly-expensive to distinguish between low- and high-risk insurance applicants, the insurer prices insurance contracts at an average premium for all individuals. That results in undercharging high-risk customers and overcharging low-risk customers for similar contracts.

Past experience suggests that most popular crop insurance schemes, particularly multi-peril yield insurance and revenue insurance, are rather prone to adverse selection and moral hazard. Goodwin (1993) illustrates the effects of adverse selection on the actuarial performance of the US crop insurance program, demonstrating that only farmers whose risk is above average are likely to purchase insurance. The results of a study conducted by Just et al. (1999) suggest that participating farmers tend to be those with higher-than-expected indemnities, as farmers with lower-than-expected indemnities are priced out of the program. They conclude that the domination of high-risk farmers in the insurance market can lead to market failure.

Miranda (1991) argues that area-yield insurance offers numerous advantages over individual-yield crop insurance. Because information regarding the distribution of the area yield is generally available and more reliable than information regarding distribution of individual yields, insurers could more accurately assess the actuarial fairness of premiums under an area yield policy, thereby significantly reducing adverse selection problems. The use of an insurance product based on an index should eliminate the problem of asymmetric information between government and insurance companies, as well as between insurance companies and farmers, since all involved parties have symmetric information regarding the contract, and problems of moral hazard and adverse selection can be reduced significantly. However, Skees and Reed (1986) show that the potential for adverse selection depends on a farmer’s subjective assessment of the expected yield and the variability of the yield. They argue that premium rates based only on the mean crop yields of a region can lead to adverse selection, particularly when the variance of yield fluctuates considerably between farms. This aspect might be even more serious in a transition country, where farm productivity and production technologies could be rather heterogeneous in the initial stage. In this view, weather-based index insurance products provide some advantages because of the objective nature of the parameters that trigger indemnity payments. Varangis et al., (2002) argue that the weather can be independently verified, and therefore is not subject to the possibility of manipulation. Pre-conditioned, reliable assessment of area-yield based insurance can have similar benefits to weather-based index insurance.

3.2 Incentives for farmers and insurance companies to participate in crop insurance

Realization of the law of large numbers is closely connected to incentives for farmers to buy insurance. If insurance is voluntary, then farmers’ participation in crop insurance would depend on, among other factors, how well it is suited to their needs. According to the conducted farm survey in Kazakhstan, features of insurance contracts such as sensitivity to changes in weather conditions (60.8 percent of the respondents), timing of contract fulfillment (44.6 percent) as well as the possibility of selecting a reasonable coverage (28.4 percent) and regional differentiation in contract design (24.5 percent) were referred to as main preconditions for the farmers' participation in crop insurance. Additionally, the farmers mention the cost of insurance as an important factor of their willingness to buy insurance. In this view, most farmers would tend towards insurance against only a group of the most serious natural hazards they face, as opposed to multi-peril insurance, provided that it would lower insurance costs. According to survey results, drought represents the most important natural hazard to grain production in the region, therefore, weather-based index insurance is likely to be accepted by farmers there.

However, since other important risks cannot be insured under this insurance product, farmers with multiple risks may desire another insurance scheme to provide coverage against their further risks. On the other hand, insurance contracts that are designed to protect against losses from a multitude of hazards may present challenges in terms of accurately assigning a probability of loss and determining an appropriate insurance rate (Goodwin, 2001). This issue is even more critical if only limited historical yield data is available, as is the case in transition countries, where, due to restructuring, new entities have been emerging. Using regional data, however, may not accurately reflect the true likelihood of losses for individual farmers. As Miranda (1991) suggests, area-yield crop insurance provides incentives to farmers whose yields strongly correlate with the aggravate area yield. As the farm survey results demonstrate, this applies for most large farms in the investigated regions. Therefore, this insurance product can find acceptance by large farmers in Kazakhstan as well.

Furthermore, farmers, who in addition to high yield-variability face high price risk, could be interested in a revenue insurance scheme. In the context of an underdeveloped market infrastructure, price risk is of great importance to Kazakh farmers. According to the farm survey results, 64.4 percent of the interviewed farmers would like to have income insurance (Heidelbach et al., 2004).

Another important aspect of insurance market development associated with insurability is readiness of the private insurance sector to extend their services to agriculture. As results of structured interviews with insurance experts in Kazakhstan show, insurance companies are strongly distrustful to business in agriculture. Most of them do not possess any expertise in providing agricultural insurance. Those small parts of insurance companies, which do have some experts in the field, do not believe that risks in Kazakh agriculture can be privately insured. Additional aspects that hold them from involvement in the crop insurance market are high administrative and transaction costs, problems with monitoring and controlling moral hazard, and heavy regulation of the crop insurance market. Considering that both, area-yield insurance and weather-based-index insurance possess some advantages compared to traditional insurance products with regard to the above-mentioned problems, they could serve as an "lead-in" for private insurance during the initial stage of development in the private insurance market in a transition economy. However, area-yield crop insurance, as well as weather-based-index insurance, does not solve the problem of risk pooling when systemic risk is present. In this case, an engagement on the side of either state or financial markets is inevitable for dealing with the problem.

3.3 Effects on farmer's production patterns

An important issue treated in the literature concerns effects of insurance on farm productivity and production practices (Chambers and Quiggin, 2002; Coble et al., 1997; Smith and Goodwin, 1996). Reducing farmers' risk through insurance has been identified as affecting land use and inducing changes in production decisions. The effects of crop insurance on production pattern changes originate from the fact that under crop insurance, risk-averse farmers will behave as if they were risk-neutral (Chambers, 1989). In view of the problem of marginal production areas with less productive farms in Kazakhstan and some other transition countries, this effect of insurance can be even more serious and severely distort factor allocation. Crop insurance can motivate farmers to choose a riskier bundle of outputs, inputs, and production practices that make farming more risky. Regarding this general problem, the literature concerns the optimal design of insurance contracts. Chambers (1989) considers a contract-based approach, where insurance is designed with respect to an incentive compatibility constraint based on the agent's first-order conditions for choice of inputs. Miranda (1991), Mahul (1999) and Bourgeon and Chambers (2003) examined the design of area-yield crop insurance with regard to the farmers "beta"-coefficient relating a farmer's yield to the risk pool's yield.

On the other hand Chambers and Quiggin (2004) argue that by having access to fair insurance, the producer does not need to engage in costly self-insurance. In the framework of state-contingent approach the authors show that by looking for a cost-minimising bundle of risk management tools and the technology to reach the optimal level of state-contingent income, the producer will be required to equalise the rate at which the risk management tool and technology balance out the state-contingent incomes. In this context the challenge is to apply this approach to empirical investigations into crop insurance design and pricing.

3.4 Feasibility and financial viability

Feasibility of an insurance scheme plays an important role considering applicability and viability of an insurance product. From this point of view, index-based insurance schemes provide some important advantages over other insurance schemes. Primarily due to their capacity to reduce transaction costs on the insurance market. For instance, in the case of transition countries where many small farms have emerged, area-yield crop insurance could allow to manage to some extent the problems of limited data availability. On the other hand, as serious differences in farm productivity could be present during transition, using area-yield as a reference value for risk pooling should be considered with caution. Thus, weather-based insurance can be viewed as a more advanced insurance product under these circumstances. Like other crop insurance products, weather-based insurance cannot solve the problem of systemic risk pooling. However, due to similarities with weather derivatives, weather-based index insurance can prepare farmers for the potential adoption of such advanced financial instruments. An important precondition regarding the establishment of a weather-based index insurance product is the development of hydro-meteorological services and the provision of reliable and affordable weather information for insurance market participants. This issue underlines the importance of institutional frameworks. As most transition economies experience high budget restrictions, policy-makers have to pay attention to the insurance schemes which can be run privately, without any subsidization, or only on a small scale. Most attention must, however, be paid to the institutional accompaniment of the development of rural financial markets, in particular the crop insurance market.

At the initial stage of insurance market development, a great deal of attention must be paid to educating potential customers on insurance matters. In light of bad experiences with insurance during the Soviet era, farmers in most transition countries are skeptical about crop insurance. Hence, pilot projects must be started to convince farmers of the advantages of their participation in the initial stages of crop insurance market development. In this regard, a strong engagement of government and public agencies must be present.

To summarize, in the view of a less-developed financial market in a transition economy, crop insurance can be considered as a possible instrument of a farmer's income stabilization. The analysis shows that area-yield insurance and weather-based index insurance provide more advantages compared to multi-peril crop insurance and revenue insurance also in the transition context. These advantages include:

- AYCI and WBII are introduced to manage systemic risk;
- since only systemic risk is to be insured, insurers can more accurately assess the actuarial fairness of premiums, and thus reduce the adverse selection problems;
- both schemes have relatively low transaction costs;
- AYCI is better applicable given prevailing data limitations;
- WBII is less bureaucratic, and thus provides less scope for corruption;
- WBII is better positioned to avoid moral hazard because of objective nature of parameters that trigger indemnity payments.

Nevertheless, some important issues remain unresolved even by introducing these advanced insurance schemes:

- AYCI and WBII do not solve the problem of risk pooling;
- neither of them provide protection against price risk;
- there exists a danger that risk-averse farmers may change their production patterns in a way that increases systemic risk;
- AYCI can lead to adverse selection since it is based on average yields of a region;
- WBII is attractive for those farmers, who look for insurance against only one, most serious risk - other important risks cannot be insured;
- risk-averse farmers could prefer farm-level insurance to area products, thus WBII might be more attractive for them compared to AYCI.

With account of these critical issues both schemes have been considered in the quantitative analysis that is presented in the next section.

4 QUANTITATIVE ASSESSMENT OF INSURANCE PRODUCTS

Weather-based index insurance is considered in the analysis by introducing rainfall-based index insurance (RII) and drought-index insurance (DII). In addition to area-yield insurance, they are evaluated with respect to their capacity to represent farmers' risks accurately and provide a proper basis for assessment of an actuarially fair premium.

4.1 Procedure and Data

To conduct the quantitative part of the analysis the study employs a procedure which contains the following steps:

- Index selection and design, estimation of the weights for the parameters included in an index;
- Numerical simulations to assess index distributions;
- Assessment of the expected indemnity and fair premium;
- Calculation of appropriate insurance price to assess the farmer's readiness to purchase insurance.

The most important steps of the procedure will be discussed in the next subsections.

To evaluate yield dependence on the annual weather conditions, yield data from 12 large grain farms, in the Atbasar-rayon in the Akmola-region were employed. Yield data covers the period from 1983 to 2002. Different functional forms were used to de-trend the farm's yields to account for technical change[4]. Since no time trend was found, the further analysis uses the farm yields without detrending[5].

Additionally, data from a weather station in the same region has been used in the analysis. Weather data corresponds to the period from 1974 to 2003 and encloses:

- daily precipitation (mm),
- average daily temperature (°C) and
- productive soil moisture in a one-meter soil horizon on May 18 in respective years.

4.2 Index Selection and Design

As results of the farm survey indicate, drought presents a major source of production risk over widespread areas in Kazakhstan (Heidelbach et al., 2004). In view of the severity of the problem, much research has been done in Kazakhstan on the drought phenomenon, its consequences for agriculture, and instruments to manage its effects on farm. In the literature, drought is defined as a natural phenomenon induced by a continuous and substantial deficit of precipitation, accompanied by high air temperature, which, due to evaporation and transpiration, causes the drainage of productive soil moisture, and thus unfavorable vegetation conditions (Shamen, 1997). Three types of drought are distinguished: atmospheric and soil drought as well as dry wind. To be able to assess its extent, different measures of drought were introduced.

Selyaninov (1958) (quoted in Shamen, 1997) suggested to identify drought by using an index accounting for the effects of two factors: precipitation and temperature. He introduced the so-called hydro-meteorological coefficient (*HTC*):

[4] Linear, piecewise-linear, second and third degree polynomial and exponential functions were considered.

[5] Appendix D illustrates the yield development patterns in several (randomly selected) farms in the considered rayon.

$$HTC = 10\frac{\sum R}{\sum T}\,, \tag{1}$$

where ΣR is cumulative precipitation in mm during the period with an average daily temperature ≥ 10 ^{0}C; ΣT is the sum of the average daily temperature in degrees Celsius in the same period. Selyaninov demarcated weak drought when $HTC \geq 2$, middle drought when $2.0 < HTC < 1.0$, and strong drought when $1 \leq HTC \leq 0.5$.

Later on, Ped (1975) (quoted in Shamen, 1997) suggested to measure drought by means of an index (S_i), which considers, additionally to precipitation and temperature, soil moisture:

$$S_i = \frac{\Delta R_i}{\sigma_R} + \frac{\Delta Q_i}{\sigma_Q} - \frac{\Delta T}{\sigma_T}\,, \tag{2}$$

where ΔR, ΔQ and ΔT stand for differences between long-term average and the *i*-considered period level of precipitation, soil moisture and temperature, respectively; σ_R, σ_Q and σ_T are their long-term coefficient of variation. Ped then defined the drought extent as weak if $S_i = 1….2$, medium if $S_i = 2….3$ and strong if $S_i > 3$.

More recently, another drought index was introduced by Bova (Greengof et al., 1987), who suggested to assess the extent of drought (K) by using the following formula:

$$K = \frac{10(W + R)}{\sum T}\,, \tag{3}$$

where W is the productive soil moisture in a one-meter soil horizon in springtime, R is cumulative precipitation from springtime until the moment of index assessment, and T is the sum of the average daily temperature in the period, with an average daily temperature ≥ 0 ^{0}C.

In this study, all three presented drought indexes are examined and serve as a basis for the development of a drought-index insurance product.

To prove suitability of the selected indices to reproduce weather conditions in the individual years, their correlation coefficients with wheat yields for every of the 12 farms were calculated. Table 2 represents the minimum, maximum, and average correlation coefficients between the farm yields and annual magnitudes of different weather indexes[6]. The average correlation coefficients are presented in the last column of the table. The results show that the performance of the indices is varying. The highest degree of dependence is observable in the case of area yield. All drought indices also possess a strong correlation with the yields of several farms. The maximum correlation coefficients reach values 0.81, 0.85, 0.87 in the case of the drought indices by Selyaninov, Ped and Bova, respectively. It could be supposed that the highest correlation coefficients might be observable in case of the farms which are located in the weather station surrounding area. However, this was not always the case. By introducing data on the farms' yields power we could find out that the highest correlations are characteristic for the farms in the areas with low soil quality (yield power less than 35 points). In the farms with higher yield power the correlation between the yields and the selected indices is lower. This indicates that weather conditions influence production in the farms with less productive soils more seriously than in those with relatively good soils.

Table 2 Minimum, maximum and average correlation coefficients between selected indices and farm-level yields (Atbasar-rayon in the Akmola-region)

Summer Wheat	minimum	maximum	average
From 1983 to 2002			
Drought Index by Selyaninov*	0.43	0.81	0.50
Drought Index by Ped*	0.52	0.85	0.58
Drought Index by Bova*	0.52	0.87	0.56
Cumulative Precipitation in the growing period, in mm	0.37	0.78	0.47
Annual Precipitation, in mm	0.33	0.75	0.49
Area Yield	0.74	0.98	0.79

** - drought indexes were calculated to correspond to the growing period (June1 - August 31).*
Source: own calculation based on data, which was collected during the farm survey.

In our further analysis we used all drought indices and the rainfall-based index in addition to AYI and applied them to a farm with a high correlation between yields and weather indices[7].

To improve the performance of the selected indices we modified them by introducing monthly data and fitting them to the farm data. By means of least square regression the effects of the weather parameters (independent variables) on the farm's wheat-yields (dependent variable) were estimated and the following index structures (shapes/configurations) were identified[8].

Rainfall-based index, R^2=0.80

$$0.09(0.03)R_{May} + 0.09(0.02)R_{June} + 0.08(0.02)R_{July} + 0.1(0.03)R_{August} + 0.03(0.02)R_{Sept-April}, \qquad (4)$$

where R is the cumulative rainfall (or precipitation) in a particular month;

Drought index by Selyaninov, *(modification)*, R^2=0.80

[6] First, correlation coefficients were calculated for every large farm in the rayon, then the highest and lowest coefficients were selected.
[7] Descriptive statistics of the data employed is to find in the Appendix D
[8] Standard errors in parentheses.

$$0.09(0.03)R_{May} + 1.27(0.29)\frac{R_{June}}{T_{June}} + 1.48(0.33)\frac{R_{July}}{T_{July}} + 1.7(0.49)\frac{R_{August}}{T_{August}} + 0.03(0.02)R_{Sept-April}, \quad (5)$$

where R is the cumulative rainfall (or precipitation) and T - the average daily temperature in a particular month;

<u>Drought index by Ped *(modification 1)*, R^2=0.81</u>

$$1.80(0.59)\frac{\Delta R_{June}}{\sigma R_{June}} + 2.19(0.64)\frac{\Delta R_{July}}{\sigma R_{July}} + 1.53(0.61)\frac{\Delta R_{August}}{\sigma R_{August}} - 1.26(0.59)\frac{\Delta T}{\sigma T} + 1.29(0.57)\frac{\Delta Q}{\sigma Q}, \quad (6)$$

where R is the cumulative rainfall in a particular month, T - the average daily temperature between June 1 and August 31 and Q is the soil moisture as on May 18;

<u>Drought index by Ped *(modification 2)*, R^2=0.79</u>

$$2.22(0.68)\frac{\Delta R_{June}}{\sigma R_{June}} + 2.77(0.67)\frac{\Delta R_{July}}{\sigma R_{July}} + 1.83(0.67)\frac{\Delta R_{August}}{\sigma R_{August}} - 1.0(0.65)\frac{\Delta T}{\sigma T} + 1.12(0.66)\frac{\Delta R_{Sept-May}}{\sigma R_{Sept-May}}, \quad (7)$$

where R is the cumulative rainfall from June 1 to August 31;

<u>Drought index by Bova *(modification)*, R^2=0.77</u>

$$1.32(0.22)\frac{R_{June-Aug}}{T_{June-Aug}} + 0.93(0.33)\frac{Q}{T_{June-Aug}}, \quad (8)$$

where R is the cumulative rainfall, T - the average daily temperature from June 1 to August 31 and Q is the soil moisture as on May 18.

Since soil moisture is a parameter, which is related to soil cultivation intensity, using soil moisture as a parameter for an insurance product could induce moral hazard problems. Therefore, we modified the drought index by Ped by replacing data on soil moisture through data on cumulative precipitation in the period from September and May.

As it can be seen in (4) to (8) almost all parameters estimates are statistically significant; except the case of the parameter of cumulative precipitation between September and May in the Selyaninov-index and the same parameter in the rainfall-based index. Moreover, all selected weather-indices explain a substantial portion of annual yield volatility of the selected farm. The R-square measures range between 0.77 in the case of drought index by Bova and 0.81 for the first modification of the drought index by Ped. Correspondingly, the range of correlation between the modified weather indices and the farm's wheat yields is between 0.87 and 0.90. However, in view of the above-mentioned concern with respect to use of soil moisture as a parameter for insurance pricing, we decided to exclude those drought indices, which enclose soil moisture measures, from an extended analysis.

4.3 Assessment of Fair Premium and Appropriate Price

In this section, four insurance products are evaluated with respect to their capacity to present an appropriate base for accurate insurance pricing and a proper instrument of production risk reduction. These are:

- Rainfall-based index insurance;
- Drought index insurance 1 (modification of the Selyaninov-Index);
- Drought index insurance 2 (second modification of the Ped-Index);
- Area-yield crop insurance.

We compared these insurance schemes by considering their ability to provide an actuarially sound insurance pricing and evaluated them with respect to their accuracy in assessing fair premium and its correspondence with the actual yield loss. The actual loss was defined as an expected loss and thus is the expected negative difference between the farm yields in the individual years and the expected farm yield:

$$E(Loss) = E(y_i - E(y)), \qquad (9)$$

where y_i is the yield in the year i $(i \in T)$ and E(y) is expected yield.

Actual yield loss was calculated by employing the farm yield data corresponding to the period from 1983 to 2002. The insurance products were compared by considering the closeness of the assessed fair premiums to the actual loss.

Distribution estimations and generation of the index values were done by means of @risk and several add-in-programs for MS-Excel[9]. Two approaches were used to generate large numbers of weather-indices. The first approach employed the following procedure: using historical weather data as a particular index was calculated, then its historical probability distribution was assessed and after that an index distribution with 10000 sample points was simulated[10]. The second approach was based on the generation of a multivariate distribution of the parameters, which are included in the individual indices[11]; in doing so, the correlations between the individual weather parameters were taken into account. In the first stage mean values, standard deviations of the index parameters as well as covariance matrixes were calculated, after that index parameters were jointly simulated as uniform variables of a multivariate normal distribution, and finally the generated weather parameter sets were

[9] NtRand (Version 2.01) and Matrix.xla.

[10] According to the Anderson-Darling (AD) and Kolmogorov tests area yields in the considered rayon are distributed as a Weibull-distribution. With respect to the weather indices best fit was provided by a Log-logistic distribution in the case of the rainfall index and drought index by Selyaninov (AD and Kolmogorov tests); drought index by Ped is distributed as an Inverse Gauss distribution with respect to Chi-square and AD tests.

[11] These parameters are presented with respect to the considered weather indices in the formulas (4) – (9).

used to calculate the index values. With regard to area-yield insurance only the first procedure was employed.

Fair premium

We used the generated index values to assess fair premiums and appropriate price of insurance. To identify the fair premiums an indemnity function was employed (Turvey, 2001):

$$indemnity = \begin{bmatrix} 0 & if\ x > strike \\ strike - x & if\ x \leq strike \end{bmatrix} * \lambda\ , \tag{10}$$

where *x* is the index value in the individual years and λ stands for liability.

As it could be seen in equation (10), the indemnity function defines a weather-contingent contract as a put option, that would provide an indemnity if the index value falls below a strike level. In this study, the index strike level was defined as the average level of a particular index. To be able to compare the weather-index insurance products with the area-yield insurance, in contrast to the studies on weather derivatives (Turvey, 2001, Berg et al., 2004), liability was set to correspond to the average farm's wheat yield in this study. Moreover, all estimations were completed assuming 100 percent insurance coverage[12] and in 0.1 tonnes per hectare.

The assessment of fair premium in case of area-yield insurance was conducted by the application of an indemnity function specified as

$$indemnity = \max\left[\frac{\alpha_i \mu - y}{\alpha \mu_i} \mu \phi_i , 0\right], \tag{11}$$

where y stands for the realized area yield, $\alpha_i \mu$ is the critical yield and ϕ_i responds the optimal level of coverage for the farm *i* (Mahul, 1999; Skees et al., 1997).

Both indemnity functions were additionally employed to assess expected indemnity by means of the "burn rate" method. This method is often applied in actuarial practice and assumes that future losses will be distributed as in the past. In this analysis we assessed these values in addition to fair premium to prove the performance of the considered insurance products in the short-run using the yield and weather data from 1983 to 2002.

Appropriate price

To assess the readiness of farmers to purchase insurance, a formula derived by Chambers and Quiggin (2004) in the framework of state-contingent approach can be applied. The appropriate price

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[12] In the case of area yield insurance the optimal level of coverage was applied. To determine the optimal level of coverage the critical β as specified by Miranda (1991) was assessed by means of a regression equation.

indicates the maximal price that the farmer is ready to pay for one unit of insurance and is defined as follows:

$$v^* = \sum_s \frac{c_s(w,z)}{p_s} a_s , \tag{9}$$

where c_S are marginal costs in state *s*, p_S stands for output price in state *s*, a_S represents payout (indemnity) in state *s*, *w* is input price, and finally z_S is stochastic production in state *s*.

The formula allows comparing farmer's activities to manage risk through production decisions as well as an insurance. Thus, an insurance is plausible as far as it is not more then the cost of increasing revenue by one unit in every state of nature.

Applying this formula to our empirical investigation we had to define the farm's output prices and marginal production costs. This was a challenging task with respect to the data that was available in the framework of the study. Since no price and production data was available from the considered farm, the study employed regional price data over the period from January 2000 to June 2004 and used data on production costs, which were assessed for the current level of technology employed on most large farms in the respective agri-climatic zone of the Akmola-region (Sigarev, 2003).

To account for the possible presence of natural hedge, different levels[13] of correlation between output price and index values were considered. We considered correlation coefficients between output price and index values instead of the correlation between output price and farm yield because only these variables are introduced into the appropriate price formula. Output prices are introduced directly into the formula and index values are considered indirectly through the parameter a_S – indemnity, which is subject to the index value in state *s*. In case of parametric insurance the farm's yields are not used for assessing indemnity, but natural hedge could be observed even better on a region-level, in our case the rayon-level. Thus, considering area-yield insurance it is legitimate to use the correlation between area yield and price. Further, since specific weather events determine farm yields, in case of presence of natural hedge they have to demonstrate a negative correlation with price as well. Therefore, in case of weather-index insurance we decided to concern this issue by accounting for a negative correlation between a weather-index and price. As the estimation results show, the appropriate price slightly decreases with increasing absolute values of the correlation coefficients between price and index values. This is in accordance with empirical evidence and shows that farmers are less willing to buy insurance when they can compensate their production losses by higher prices.

The empirical estimation of marginal production costs in different states is an object of our further in-depth investigations. For the moment, we decided to assess this value by using the average instead of marginal production costs. Additionally, we had to assume a constant technology so as to use the same level of costs over all states of nature. This illustrates that our estimates of appropriate price are rather

[13] In our analysis we considered the following values of the correlation coefficients: 0, - 0.1, - 0.3, - 0.5.

rough and should be considered just as an approximation. Consequently, a more advanced investigation is required to introduce the concept of appropriate price into empirical research.

Estimation Results

In Table 3 the estimation results are presented with respect to the individual indices. The actual loss was calculated using the selected farms' yields and has an expected value of 1.89 tonnes over the period from 1983 to 2002. The fair premium was assessed on the basis of the generated index values. Estimations of the expected indemnity as well as the appropriate price were done using historical weather data in the above-mentioned period.

As the estimation results show there are some differences in the estimated values of the fair premium with respect to the simulation procedures of the index value generation; particularly in the case of the rainfall-based index and drought index 1. That can be explained by different assumptions with respect to the probability distributions. Using the parameters simulation procedure, a multivariate normal distribution was assumed. In the procedure of direct index simulation, Log-logistic distributions were employed to generate the rainfall-based index and drought index 1 (by Selyaninov) and an Inverse Gauss distribution was applied in case of drought index 2 (by Ped).

Considering the estimations of the fair premium and the expected indemnity the lowest differences in their assessment could be found with regard to drought index insurance 2 and area-yield insurance. This indicates that these insurance products provide more precise estimates also in a short-run, and is an important aspect for actuarial practice.

Table 3 Preliminary results of a numerical analysis (data from a farm and a weather station in the Akmola-region; 100 % coverage; 0.1 t per ha)

Insurance based on:		**Rainfall-based Index**	**Drought Index 1**	**Drought Index 2**	**Area-Yield Index**	**Area-Yield Index (optimal coverage)[1]**
Expected Loss		1.89	1.89	1.89	1.89	1.89
Fair premium	estimated by index simulations	1.64	1.62	1.64	1.60	1.65
	estimated by index parameters simulations	1.54	1.47	1.66	n.a.	n.a.
Expected Indemnity (estimated by burn rate method)		1.67	1.73	1.68	1.57	1.63
Appropriate price[3]		1.56 - 1.64	1.55 - 1.63	1.54 - 1.62	1.43 - 1.50	1.48 – 1.56

Difference between	fair premium and indemnity[2]	0.92 - 0.98	0.85 - 0.93	0.98 - 0.99	1.02	1.01
	indemnity and loss	0.89	0.92	0.89	0.83	0.86
	fair premium and appropriate price[2]	0.95 - 1.01	0.96 - 1.11	0.93 - 0.99	0.89 - 0.94	0.90 - 0.95

1 - according to the estimates 104%; [2] - minimum and maximum percentage; [3] - estimated by assuming presence of natural hedge.
Source: own estimations

Comparison of expected loss and indemnity estimates shows that there is no insurance scheme which provides a complete coverage of the farm's crop losses. This was to expect, since weather-based insurance provides protection against only one, usually the most important risk, in this case – drought, and area-yield insurance covers only systemic yield losses (e.g. idiosyncratic risk remains uninsured). However, all weather-based insurance products minimize the differences between expected indemnity and loss. This fact supports the argument that drought presents the most important natural hazard in the considered region.

Further on, for all insurance products the estimates of appropriate price approach the fair premium values. However, as appropriate price identifies the maximum price that the farmer is ready to pay for an insurance, it must be lower than the insurance premium. With respect to rainfall-based insurance and drought index (1) insurance no clear assessment is possible: the ratio of fair premium to appropriate price varies between 0.95 and 1.01 and 0.96 and 1.11, respectively. Conversely, in the case of three other insurance products the estimates of appropriate price is definitely lower than the fair premium. This indicates good prospects with respect to the farmers' participation in crop insurance.

By way of summarizing the discussion of the estimation results, the analysis and comparison of the selected insurance products show that two of them, drought index (2) insurance and area-yield insurance, provide a better basis for developing crop insurance in the considered region. However, further investigations are necessary before these insurance products can be recommended for introduction. This concerns both empirical and methodological issues. Our investigations into insurance contract design were based on the data from only one farm in the considered region. It remains to be proven empirically whether and which of the considered insurance products provide an adequate instrument of risk management to other farmers in this as well as other regions of Kazakhstan. Additionally, substantial effort is necessary to improve the empirical application of the appropriate price concept.

5 CONCLUSIONS

Due to the slow development of financial markets and the scarce provision of financial services to farmers in many transition economies, crop insurance can present an initial instrument of farmers' income stabilization. The analysis shows that most of the important aspects of insurance markets in developed countries can be applied in a transition economy as well. However, additional issues can arise in establishing crop insurance in this context. Depending on the extent of these problems, several insurance products could be assessed in terms of their potential and applicability in an individual transition country. The complexity of the problems to be treated in the transition process involves and requires the gradual development of crop insurance markets. This would allow the accumulation of extensive knowledge and experience for the development of a long-term strategy which aims to increase sustainability of farming. As first estimations show, in the case of Kazakhstan, introducing drought-index insurance or area-yield insurance for large farms in the grain-producing regions seems to have good prospects. Initial preconditions for that are analyzed in this study. However, in view of the problem’s complexity, further investigations are necessary.

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APPENDIX

Appendix A Development of sown area in Kazakhstan during transition

Oblasts	Total, th. ha			Share in sown area, %	
	1990	2002	2002/1990	1990	2002
Total	35182.1	17756.3	0.50	100.00	100.00
Akmola	6393.8	4116.0	0.64	18.17	23.18
Kostanai	6804.7	3614.3	0.53	19.34	20.36
North KZ	4971.4	3413.1	0.69	14.13	19.22
North Kazakhstan (area with extensive grain production)	55342.0	30901.7	0.56	51.65	62.76
Karagandy	2325.4	1129.6	0.49	6.61	6.36
East KZ	2702.0	941.4	0.35	7.68	5.30
Pavlodar	3389.7	849.6	0.25	9.63	4.78
Aktobe	2706.6	821.5	0.30	7.69	4.63
West KZ	2038.6	680.0	0.33	5.79	3.83
Regions with marginal production areas	13162.3	4422.1	0.34	37.41	24.90
Almaty	1577.1	816.7	0.52	4.48	4.60
South KZ	1074.3	731.4	0.68	3.05	4.12
Zhambyl	861.1	498.0	0.58	2.45	2.80
South Kazakhstan (irrigated area)	3512.5	2046.1	0.58	9.98	11.52
Kzyl-Orda	253.5	140.0	0.55	0.72	0.79
Atyrau	82.2	4.6	0.06	0.23	0.03
Mangistau	1.7	0.1	0.06	0.00	0.00
Semi-desert area	337.4	144.7	0.43	0.96	0.81

Source: Selskoje, lesnoe i rubnoe chozjaistvo Kasachstana, Almaty 2003

Appendix B: Comparison of insurance products with regard to their applicability in a transition economy

Criterion	Multi-Peril Yield Insurance (MPYI)	Farm Gross Revenue Insurance (FGRI)	Area-Yield Crop Insurance (AYCI)	Weather-based- Index Insurance (WBII)
<u>Insurability</u> Realization of law of large numbers	<u>compulsory</u>: (+) more probable; (-) affects activity of individual farmer's decision making; (-) more regulative. <u>voluntary</u>: (-) less probable, (+) through provision of a variety of individual insurance products can offer incentives to farmers to buy insurance, consequently, a higher farmer participation rate.			
Systemic risk	(-) do not consider the problem.		(+) introduced to manage systemic risk (Miranda, 1991), however, subject to the extent of systemic risk.	
Problem of asymmetric information	(-) prone to moral hazard and adverse selection		(+) potentially less AS, since only systemic risks are to be insured;	
			(-) since based on mean yields of a region, can lead to adverse selection, (Skees and Reed, 1986).	(+) have more potential to avoid moral hazard because of objective nature of parameters that trigger indemnity payments.
Incentives for farmers to buy insurance	(+) almost all hazards can be insured; (+) more risk-averse farmers prefer farm-level insurance to area products	(+) almost all hazards can be insured; (+) provides protection against price decline as well as low yields.	(+) attractive for farmers if their yields strongly correlate with the aggregate area yield (Miranda, 1991).	(+) attractive for the farmers who look for insurance against only the most serious risk; (-) other important risks cannot be insured.
Incentives for private insurance companies to provide crop insurance	(-) high monitoring costs	(-) rather regulative; (-) high transaction costs.	(+) relatively low administrative and transaction costs (Miranda, 1991; Schnitkey et al., 2003);(+) insurers could more accurately assess the actuarial fairness of premiums, thereby reducing adverse selection problems (Miranda, 1991); (-) area yield insurance does not solve the problem of risk pooling (Mahul, 1999), the same regards weather-based -index insurance.	
Possible effect on productivity and production patterns	(-) can affect use of on-farm risk-management instruments as well as alter production patterns.	(-/+?) can have effects on productivity.	(-) danger that risk-averse farmers may change their production patterns in a way that increases systemic risk (Chambers and Quiggin, 2002), and thus, can increase production risk in general.	
			(-) can restrain farmers from increasing their productivity and maintaining on-farm risk management instruments.	
Feasibility (applicability in a transition country)	(+) mostly well-known in the post-Soviet countries, hence less avowal at the beginning; (-) high administrative costs (-) limitations in data availability.	(-) production structures in most farms are constantly changing: it is therefore necessary to reassess farm revenues often. Thus, high transaction costs are unavoidable (-) limitations in data availability.	(+) feasible given prevailing data limitations (small individual farms) (Skees et al., 1999); (-) there could be serious differences in farm productivity in initial stage of transition. This might make AYCI less attractive to more productive farms.	(-) high initial costs for establishing a dense network of weather stations (costs depend on the actual state and density of the weather station net); (+) low administrative costs and less bureaucracy, thus less scope for corruption.
Financial viability of insurance scheme	(-) difficult to achieve in view of limited budget resources to subsidize insurance schemes.		potentially possible (Skees, 1999).	

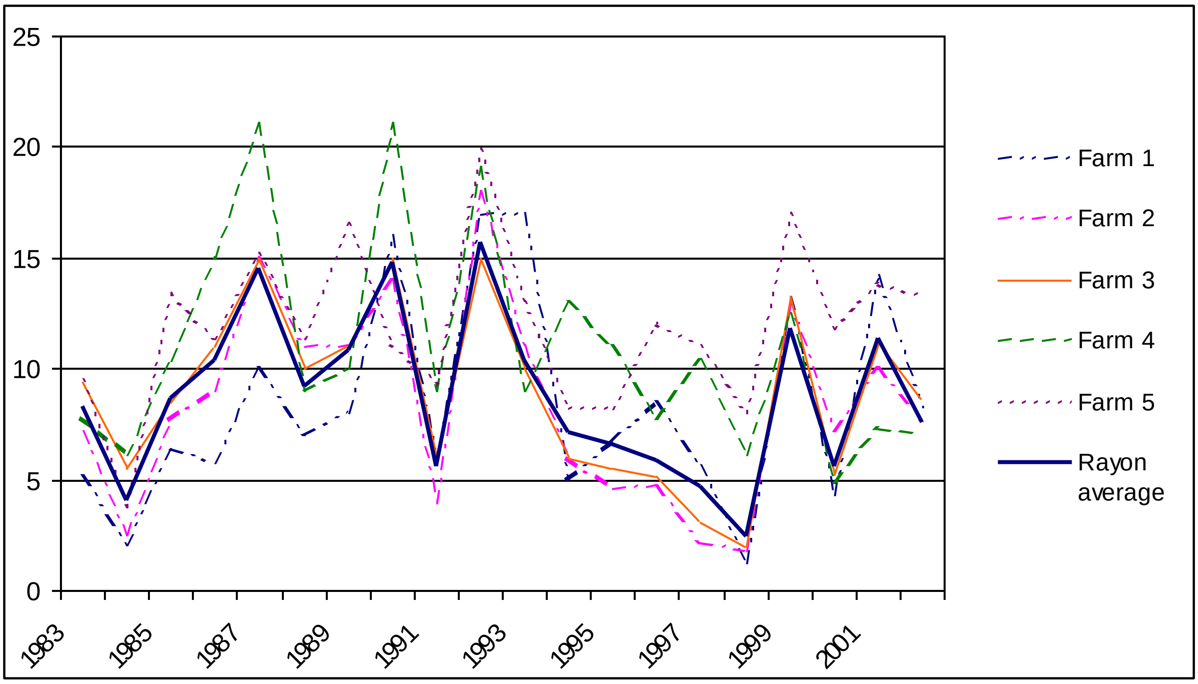
Source: own presentation

Appendix C Grain yield correlation in Kazakhstan 1970-2001

	Akmola	Aktobe	Almaty	Atyrau	East-Kaz	Zhambyl	West-Kaz	Karagandy	Kostanai	Kzyl-Orda	Pavlodar	North-Kaz	South-Kaz
Akmola	1.00												
Aktobe	0.46	1.00											
Almaty	0.64	0.38	1.00										
Atyrau	-0.05	0.57	0.28	1.00									
East-Kaz	0.28	0.00	0.24	-0.07	1.00								
Zhambyl	0.67	0.41	0.94	0.23	0.20	1.00							
West-Kaz	0.35	0.54	0.33	0.63	0.22	0.41	1.00						
Karagandy	0.91	0.36	0.67	-0.02	0.38	0.64	0.29	1.00					
Kostanai	0.66	0.71	0.37	0.22	0.14	0.36	0.47	0.51	1.00				
Kzyl-Orda	0.25	0.31	0.11	0.05	0.38	0.13	0.37	0.24	0.40	1.00			
Pavlodar	0.64	0.05	0.49	-0.09	0.59	0.46	0.22	0.62	0.40	0.20	1.00		
North-Kaz	0.67	0.40	0.31	-0.13	0.32	0.33	0.43	0.54	0.79	0.52	0.61	1.00	
South-Kaz	0.67	0.63	0.83	0.45	0.14	0.84	0.50	0.69	0.54	0.35	0.38	0.40	1.00

Source: Kussaiynov, 2003

Appendix D Wheat yields of 5 selected farms and the rayon average yield from 1983 to 2002, 0.1 t (Atbasar-rayon in the Akmola-region).



Appendix F Descriptive statistics of the farm's and area yields and weather parameters (from 1983 to 2002, Atbasar-rayon in the Akmola-region)

	Expected value	STD	Min	Max
Farm yield, 0.1 t	8.4	4.6	1.3	17.0
Area yield, 0.1 t	8.8	3.7	2.4	15.7
Annual precipitation, mm	323.0	61.1	231.0	453.0
Cumulative rainfall in June, mm	38.6	31.2	2.4	153.8
Cumulative rainfall in July, mm	49.7	37.0	9.0	151.8
Cumulative rainfall in August, mm	31.4	22.9	3.8	92.0
Average daily temperature in June, ^{0}C	18.9	2.1	14.7	22.6
Average daily temperature in July, ^{0}C	20.4	1.7	17.8	24.0
Average daily temperature in August, ^{0}C	18.0	1.5	15.7	22.0