CROP INSURANCE MARKET DEVELOPMENT IN A TRANSITION ECONOMY:
THE CASE OF KAZAKHSTAN

Dr Olaf Heidelbach (Presenting Author)
Attaché/Project Manager
European Union
Delegation of the European Commission to the Kyrgyz Republic
Abdymomunova Str. 236
720033 Bishkek, Kyrgyz Republic
Tel.: (+996 312) 901260, ext. 104
Fax: (+996 312) 901266
E-mail: olaf.heidelbach@ec.europa.eu, olaf_heidelbach@gmx.net

Associate Professor
American University of Central Asia
205 Abdymomunova St.
720040 Bishkek, Kyrgyz Republic

Dr Raushan Bokusheva
ETH Zürich
Professur f. Agrarwirtschaft
SOL C 9 Sonneggstrasse 33 8092 Zürich
Telefon: +41 44 632 53 30
E-Mail: bokushev@ethz.ch

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Abstract

We analyze the current state and future requirements of an agricultural income stabilization mechanism in a transition country – namely, the crop insurance system in Kazakhstan. Three objectives will be pursued: First, factors influencing the development of the crop insurance market will be identified. Second, insurance’s capabilities to efficiently stabilize income under transition circumstances will be evaluated. Finally, recommendations for developing crop insurance as an effective income stabilization tool will be provided.

Results indicate that the prevailing institutional framework for establishing a sustainable crop insurance system is rather weak, and available insurance products are not preventing the problem of asymmetric information to a satisfying degree. Examination of potential insurance products suggests that area-yield and weather-index insurance is most appropriate under transition conditions. This evaluation is supported by the results of a mathematical programming model, which tests the utility-efficiency of various risk-management instruments.

JEL: D81, D82, G22, Q14

Key words: Risk-management, crop insurance, institutions, mathematical programming, Kazakhstan
Introduction

Kazakhstan’s agricultural sector plays a vital role in the country's economy. Not only does it function as an economic output producer, it also serves as a social buffer in the country’s ongoing transition to a market economy. The restructuring process has had a strong impact on the economic performance of agricultural enterprises. Indeed, as the state no longer functions as a back-up financier in times of economic downturn, farmers have had to find their own sustainable instruments for managing business risks, which are significant in Kazakhstan due to the acute continental climate and the resulting revenue fluctuations in crop production. Besides on-farm strategies that concern farm management and include production portfolio selection, holding sufficient liquidity and diversification, risk-sharing strategies can play an important role in agricultural income stabilization. Risk-sharing strategies include marketing contracts, production contracts, vertical integration, hedging on futures markets, participation in mutual funds and insurance.

This contribution attempts to shed light on factors influencing the development of the crop insurance market in Kazakhstan. Three objectives will be pursued: First, factors influencing the development of the crop insurance market. Second, crop insurance’s capabilities to efficiently stabilize income under transition circumstances will be evaluated. In the final step, recommendations for developing crop insurance as an effective income stabilization tool will be made to political decision-makers.

Problems of agricultural income stabilization and institutional history of crop insurance

In the continental-climatic vegetation conditions of Kazakhstan, plant production carries a particularly high risk, which manifests itself predominantly in the considerable volatility of yields. Comparing major grain producers’ coefficients of variation illustrates Kazakhstan’s relative comparative disadvantage in rain-fed crop production. For wheat, as well as for sunflowers, Kazakhstan ranks last in the list of most important producer countries. In both cases, Kazakhstan produces the lowest yields, with a standard deviation comparable to other
transition countries (Russia, Ukraine) that produce double the mean yield. Figure 1 depicts mean values and variation coefficients for wheat yields in selected countries.

**Figure 1: Mean and variation of national wheat yields (1980-2003)**

![Graph showing mean and variation of national wheat yields](image)


Crop insurance has a long history in the former USSR, both in general and in Kazakhstan particularly. Indeed, agricultural insurance has existed since tsarist times, but one of the characteristics of the socialist crop insurance system was a relatively rough estimation of insurance tariffs, i.e., there was not much differentiation between regions within the Soviet republics.

After the dissolution of the Soviet Union in 1991, the state insurance system was suspended. Under the national agro-food programme of the Republic of Kazakhstan, the current law “On Mandatory Crop Insurance” was adopted in 2004. However, due to the absence of insurance companies that hold a license for crop insurance activities, implementing the law in 2004 was impossible. Practical implementation started in 2005 with the beginning of the sowing
campaign. The main objective of the mandatory crop insurance law is to protect, through insurance payments, crop producers’ property from the consequences of adverse natural phenomena which might lead to partial or complete loss of harvest. The system’s main characteristics are fixed premiums (depending on the respective crop and region) and the indemnification of production costs, subject to the technology used at a farm.\(^1\) Since the law has been adopted, the dissemination process has provoked mostly depreciative reactions from farmers and farmers’ organizations. Contrary to insurance representatives’ arguments, (Tazhmakin cited in Prokhorov, 2005), it is not only poor farmers that disapprove of crop insurance. According to experience gained during extensive visits to the country, there is broad distrust of the current crop insurance system. International experience shows that large farmers and the insurance industry often profit the most from crop insurance programs.

**Insurance supply**

In the framework of the new law on crop insurance, licenses *without time limit* for insurance activities have been issued to four insurance companies. Initially, active work in concluding contracts was carried out by the former two companies, only. However, the activities of these two insurance companies turned out to be insufficient for providing complete mandatory crop insurance coverage. In 2004, the total insured area in Kazakhstan was 8,225,998 ha, which is 57.6% of the entire crop area subject to mandatory insurance (14,278,000 ha). There is a higher penetration of crop insurance in regions with a higher share of large-scale enterprises and better infrastructure, such as Akmola, Kostanai, East, and North Kazakhstan. Smaller private farms have only restricted access to insurance, even though they would need it more than large farms due to limited self-insuring opportunities. According to the statements of the then-chairman of the “Grain Insurance Company”, a company whose main interest lies in insuring large-scale farms in northern Kazakhstan, this development was predictable (Tazhmakin, 2003).

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\(^1\) There are three types of technologies ("scientifically-justified", "standard", and "extensive") that determine indemnity levels.
In 2005, during the course of practically applying the law’s norms, many shortcomings were discovered in the newly-introduced crop insurance system. Thereafter, a working group within the Ministry of Agriculture identified three main problems of the current system:

- **Monitoring**: the monitoring committee's authority is questioned by farmers and insurance companies; distances between plots are large and infrastructure underdeveloped, preventing qualified monitoring from being achieved on time;

- **Communication**: Insufficient information about the insureds' characteristics (production volume, applied technology) caused by missing collaboration between agricultural administration, statistical offices and insurance companies. Different, sometimes shady practices for transferring premiums and indemnities;

- **Inadequate provision of information** to farmers and regional agricultural administration regarding insurance mechanism and regulation: this leads to confusion and resentment among farmers in different regions, e.g. productive farmers in northern Kazakhstan do not want to subsidize highly risk-prone farms in western Kazakhstan.

Further weak points of the insurance program can be derived by studying the institutional framework and natural conditions in Kazakhstan:

- **Moral hazard** may arise, as farmers could select the highest coverage (corresponding with scientifically-justified technology), although they have used simplified technologies in the hope of increasing the probability of insurance payout.

- The law does not make a detailed distinction between low-risk areas and high-risk areas. This might expose the whole system to **adverse selection**, particularly for crops other than cereals that have a single country-wide premium rate.

- **A slow processing rate and a high claim rejection rate**. The loss adjustment is performed by a commission that determines yield loss. The first year processing rate was very low due to implementation difficulties.
In spite of many implementation difficulties, in 2006 the number of insurance contracts and the total insured area increased from the previous year in nearly all oblasts. Most farms buy insurance contracts only to avoid fines, which can be much higher than insurance premiums. Additionally, insurance penetration continues to be very low in southern Kazakhstan oblasts (South Kazakhstan, Almatinskaya, Djambulskaya, Kysylordinskaya), where small farms play a predominant role.

Another evident problem on the way to a functioning commercial crop insurance system is the *lack of interest of well-established insurance companies*. Insurer liquidity problems can be caused by systemic risk and credit-rationing. Credit-rationing could be overcome by diversifying the insurer’s portfolio with insurance types where indemnity payments are not correlated with those of crop insurance. In Kazakhstan, the insurance market is not yet fully developed, and one might question the adequacy of relatively small companies acting as a national crop insurer\(^2\). Private insurance companies clearly act as profit-maximizers by keeping transaction costs low. Interviews with selected representatives of insurance companies shed light on their attitude towards crop insurance. The interviewees mentioned several reasons for private insurers’ low interest in crop insurance:

- functionality of the scheme is highly dependent on state budget;
- non-liquidity of farms (and impossibility of choosing clients);
- lacking insurance methodology (actuarial soundness);
- superficial calculation of premiums (how to monitor production costs?);
- reinsurance difficult to attain with presence of systemic risk;
- interests of the insurance industry were not considered when formulating the law;
- insufficient and expensive access to information (e.g. weather and yield data);

\(^2\) The three actively engaged insurance companies own considerably less than average capital compared to the entire sample of 37 insurance companies in Kazakhstan (National Bank, 2006). Own capital equipment is particularly important when systemic risk prevails.
monitoring (asymmetric information problem) is not sufficiently solved by the law (no trust in the monitoring commissions).

Some of these problems could be solved by introducing index-based insurance. These products, however, were not widely tested in practice, and an introduction on a pilot-basis might be prohibitively expensive and thus not feasible for private insurance companies. Therefore, government or international donors should provide necessary expertise and financial means.

**Evaluation of potential demand for crop insurance**

Traditional crop insurance schemes that cover farm yield risk face problems of asymmetric information. Innovative index insurance contracts, such as area yield insurance or weather index insurance, may overcome these problems, but at the cost of generating basis risk for the farmers. The risk-reducing potential of index insurance contracts depends strongly on the extent to which individual farmers are affected by systemic and idiosyncratic risk, respectively. Hence, introducing index insurance schemes into the market must be preceded by an analysis of whether farmers’ risk reduction through selected insurance products generates sufficient demand for these products. By applying a utility-efficient programming model (Lien and Hardaker, 2001) to two study farms, a range of different insurance instruments will be evaluated.

Expected utility provides a convenient way to represent risk preferences: its basic idea is that decision-makers maximize expected utility. When income increases, its utility increases less than proportionately for risk-averse decision-makers. Hence, utility is an increasing but downward bending function of income. Expected utility estimates can be translated into certainty equivalents (CE), where CE is the inverse of the utility function and represents the monetary value that a person would accept to avoid a specified risk. Knowing certainty equivalent outcomes not only permits the ranking of risky alternatives, but also facilitates estimating risk premiums. CE simultaneously accounts for the probabilities of risky prospects.
and the preferences for the consequences (Anderson et al., 1977). Each production activity and application of risk management instrument may influence a decision-maker’s expected utility. Examining CE is one approach to investigating the magnitude of this influence. The utility-efficient programming model (UEP) integrates the assumptions and constraints of expected utility theory in an objective function that can be described as follows:

$$\text{max } CE = \left[(1-r)E(U)\right]^{\frac{1}{1-r}}, \quad (1)$$

where

$$CE = \text{certainty equivalent}, \quad r = \text{absolute risk aversion coefficient}, \quad \text{and}$$

$$U = 1 - \exp(1-r)z, \quad (2)$$

subject to

$$Ax \leq b, \quad Cx - Iz = uf, \quad \text{and} \quad x \geq 0, \quad (3)$$

where $A$ is a matrix of technical coefficients for all considered activities, $b$ is a vector of capacities, $x$ is a row vector of adjustable variables, $C$ is a matrix of activity net revenues by state of nature, $I$ is an $nn$ identity matrix, $z$ is the annual net income in each state, $u$ is a vector of ones, and $f$ represents fixed or overhead costs. The utility function $U(z)$ is positive $(U'(z) > 0)$, but decreasing $(U'(z) < 0)$. This corresponds to decreasing absolute risk aversion $r_a(z) = -U''(z)/U'(z) = r/z$ and constant relative risk aversion $r_r(z) = zr_a(z) = r$. The variable $r$ was set to a value of 2, which represents slight risk aversion.

The activity net revenues for all states, $C$, represent the uncertainty in activity returns. Therefore, there is no need to assume any standard form of distribution. In our case, suitable values are detrended observations of the time period 1980-2002, treated as states with assessed probabilities.

**Characterization of study farms**

As one of the study farms serves a large crop farm (34,000 hectares of sown area) in the grain belt of northern Kazakhstan. From 1999 to 2003, about 74% of the farm income was
generated by crop production, 21% by livestock production and 5% by processing. This farm is an interesting object of investigation due to its relatively high yield level, the strong weight of crop production in overall economic performance and the ‘organizational history’ of the enterprise. After a recent restructuring of the enterprise, the new organizational form is a limited liability company, where the manager holds more than half of the shares. Several years ago, the farm entity was incorporated in a supra-regionally active holding company that comprised approximately 400,000 hectares of sown area. In the past, production, credit, and insurance decisions were taken by the central planning unit of the holding company. Nowadays the general manager makes most of the important decisions.

The study farm in eastern Kazakhstan is a Limited Liability Company and was founded in 1996. It has 63 full-time employees and comprises 3,100 ha that are to a large extent sown with wheat and sunflowers. The good soil conditions can be attributed to the location of the enterprise at the foothills of the Altai Mountains. Further, the farm has relatively good access to infrastructure important for marketing its products, such as road access and short distances to the processing industry.

Table 1 provides a summary of farm characteristics such as legal form, size, income sources, and crop yield characteristics.
Table 1: Characterization of study farms

<table>
<thead>
<tr>
<th></th>
<th>North-central Kazakhstan</th>
<th>Eastern Kazakhstan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal form</td>
<td>Ltd.</td>
<td>Ltd.</td>
</tr>
<tr>
<td>Year of foundation</td>
<td>1998</td>
<td>1996</td>
</tr>
<tr>
<td>Size (crop area in ha)</td>
<td>34,272</td>
<td>3,100</td>
</tr>
<tr>
<td>Irrigated area</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of employees (mean 2000-2003)</td>
<td>100</td>
<td>63</td>
</tr>
<tr>
<td>Own capital (mean 2000-2003) in ‘000 KZT</td>
<td>349,397</td>
<td>28,795</td>
</tr>
<tr>
<td>Income from (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crop production</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td>livestock production</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>processing</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Specialization</td>
<td>wheat, barley</td>
<td>wheat, sunflowers</td>
</tr>
<tr>
<td>Average yield power</td>
<td>35</td>
<td>62</td>
</tr>
<tr>
<td>Average wheat yield (1999-2003)*</td>
<td>13.9</td>
<td>19.6</td>
</tr>
<tr>
<td>Coefficient of variation (1999-2003)</td>
<td>0.117</td>
<td>0.203</td>
</tr>
<tr>
<td>Future investment intentions</td>
<td>processing, air operations</td>
<td>-</td>
</tr>
</tbody>
</table>

*Source: farm survey data.

Description of insurance instruments

Based on Fisher’s separation theorem (Fisher, 1933), which implies that it is better to diversify through capital markets than through a combination of enterprises, the model includes various insurance and credit activities. In contrast to countries where market-based crop insurance programs are already established and abundant data is available for analysis (compare the studies of Babcock et al., 2004, Bourgeon and Chambers, 2003, Miranda, 1991, Schnitkey et al., 2003), this application requires the pre-formulation and testing of insurance and hedging products before they can be introduced to the risk programming model. A novelty of this paper is the integration of weather index insurance based on farm level data.
Skees et al., (2001) report a reduction of 29% of the aggregated regional revenue risk measured by the coefficient of variation of a portfolio of several crops measured by their regional yield in 17 Moroccan provinces. Vedenov and Barnett (2004) as well as Karuaihe et al., (2006) analyze weather-based insurance contracts for regional corn, cotton and soybean yields in two U.S. counties and for corn only in South Africa, respectively. The use of regional yields, however, underestimates farm yield deviations and severely biases analysis of yield risk reduction.

In our study we compare the effectiveness of three different insurance types – weather-based index insurance, area yield insurance and farm yield insurance with further financial risk management instruments such as credit, as well as technological risk-reducing tools available to farms in Kazakhstan.

The investigated weather index product is based on precipitation. Yearly values of the index $x_i$ are computed by the following equation:

$$x_i^{\text{Rain}} = w_{\text{May}} R_{\text{May}} + w_{\text{June}} R_{\text{June}} + w_{\text{July}} R_{\text{July}} + w_{\text{August}} R_{\text{August}} + w_{\text{Sept.-April}} R_{\text{Sept.-April}}$$

where $R$ is the cumulative precipitation, $i$ is a yearlong index and each $w$ represents a weighing factor obtained from linear regressions of the right-hand side variables using farm yields as the dependent variable.

Area yield insurance was formally described by Miranda (1991). Selected products were calibrated for the location of the considered enterprises and included in the model. Area yield insurance products are based on different underlyings, i.e., national, oblast and rayon (district) yields. Premium costs and indemnities were estimated based on historical yield and weather data for different strike levels.

Additionally, for rainfall insurance and area yield insurance, conventional farm yield insurance was evaluated. To prevent moral hazard and to obtain a comparable insurance product, the strike level for farm yield insurance was limited to 75% of the expected yield.

The following five insurance products were investigated in this contribution: National yield
insurance, oblast yield insurance (OYI), rayon yield insurance (RYI), farm yield insurance (FYI), and rainfall-based index insurance (RFI). The estimations are based on yields that were detrended and tested for structural break to establish an input data base that is not affected by technology changes. Strike yields vary between 100 and 75% of the expected yield. Estimations are restricted to areas with main crops. Special products like potatoes, fruits and vegetables are not considered in the programming model for three reasons: First, their share in total sown area is relatively small. Second, they are only partially marketed and serve, to a large extent, as the basic food supply of farm laborers. Third, since many of these crops are not grown consecutively (i.e., each year), it is not possible to derive statistically firm distribution functions for them.

A range of insurance products with adequate strike levels was selected for stepwise testing in the programming model. Besides risk-sharing instruments such as insurance, on-farm risk management instruments such as irrigation and pesticide application exist. The model takes this aspect into account by determining the utility-maximizing technology.

*Programming model results*

Results of the programming model provide answers to the question of what impact do different insurance products have on the utility of a slightly risk-averse decision-maker. A separate regional analysis was a reasonable procedure, because no general recommendations can be derived from the efficiency results.

Results for the study farm in north-central Kazakhstan stress the utility-enhancing effect of insurance, even if optimal on-farm risk management measures are applied (Table 2). If the farmer takes rainfall insurance, for example, the certainty equivalent income can be increased by 5.2% as opposed to a reference scenario without insurance. At the same time, the risk premium\(^3\) is reduced by 5.9% compared to the reference scenario. Alternative insurance

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\(^3\) The risk premium (RP) measures the largest amount of money a decision-maker is willing to pay to replace a random revenue by its expected value, and is assessed as a ratio of the difference between expected income
products also achieve better results than the reference scenario. Rainfall insurance is followed by farm yield insurance, rayon yield, oblast yield and national yield insurance. This ranking is in accordance with intuitive evaluations, since the correlation between individual farm and area yields decreases with increasing aggregation levels.

**Table 2: Certainty equivalents for different insurance product choices – study farm in north-central Kazakhstan (optimal technology)**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Insurance product</th>
<th>Certainty equivalent (in '000 KZT)</th>
<th>Utility-ranking*</th>
<th>Risk premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>- (reference scenario without insurance)</td>
<td>RFI_100</td>
<td>439,003</td>
<td>1</td>
<td>.069</td>
</tr>
<tr>
<td>R</td>
<td>FYI_75</td>
<td>434,394</td>
<td>.990</td>
<td>.081</td>
</tr>
<tr>
<td>2</td>
<td>RYI_100</td>
<td>434,272</td>
<td>.989</td>
<td>.083</td>
</tr>
<tr>
<td>3</td>
<td>OYI_100</td>
<td>427,945</td>
<td>.975</td>
<td>.097</td>
</tr>
<tr>
<td>5</td>
<td>NYI_100</td>
<td>425,057</td>
<td>.968</td>
<td>.105</td>
</tr>
</tbody>
</table>

*Note: *Achieved certainty equivalent as share of maximum achievable certainty equivalent.

Figure 2 explains how higher certainty equivalents are achieved through insurance products. Indemnity payments compensate losses and increase the net income in unfavorable states of nature. As a result, smoother income distribution increases the certainty equivalent of the risk-averse decision-maker.

and certainty equivalent to expected income (\(\text{risk premium} = (\text{expected income-certainty equivalent})/\text{expected income}\)).
Figure 2: Income stabilization through rainfall insurance

Extreme losses of up to 24.8% can be caused by the application of a sub-optimal technology compared to a situation where an optimal technology is applied (Table 3). Although the absolute losses are high, insurance can buffer sharp income shocks with an even lower risk premium compared to the results under an optimal technology.

Table 3: Certainty equivalents for different insurance product choices – study farm in north-central Kazakhstan (sub-optimal technology)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Insurance product</th>
<th>Certainty Equivalent (in '000 KZT)</th>
<th>Utility-ranking*</th>
<th>Risk premium**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RFI_100</td>
<td>312,893</td>
<td>1</td>
<td>.036</td>
</tr>
<tr>
<td>2</td>
<td>FYI_75</td>
<td>309,062</td>
<td>.988</td>
<td>.048</td>
</tr>
<tr>
<td>3</td>
<td>RYI_100</td>
<td>308,977</td>
<td>.987</td>
<td>.049</td>
</tr>
<tr>
<td>4</td>
<td>OYI_100</td>
<td>303,529</td>
<td>.970</td>
<td>.068</td>
</tr>
<tr>
<td>5</td>
<td>NYI_100</td>
<td>303,029</td>
<td>.968</td>
<td>.069</td>
</tr>
</tbody>
</table>

Note: *Achieved certainty equivalent as share of maximum achievable certainty equivalent.

The situation is different in eastern Kazakhstan, where income shocks caused by adverse weather conditions are not as extreme as in the northern part of the country. The precipitation
is higher and in addition to wheat, sunflowers are grown on a large area. This crop portfolio implies a hedge effect, since wheat and sunflower yields are not strongly correlated.

This effect explains a comparatively lower utility-efficiency of index-based insurance products compared to the northern study farm. Rainfall insurance for wheat in combination with farm-yield insurance \(^4\) for sunflowers results in an even lower CE compared to the reference scenario without insurance (Table 4). For this study farm, farm yield insurance achieves the highest CE, followed by rayon-yield insurance and a combination of oblast and national yield insurance \(^5\).

**Table 4: Certainty equivalents for different insurance product choices – study farm in eastern Kazakhstan**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Insurance products</th>
<th>Certainty Equivalent ('000 KZT)</th>
<th>Utility-ranking*</th>
<th>Risk Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>without insurance</td>
<td>27,491</td>
<td>.956</td>
<td>.082</td>
</tr>
<tr>
<td>1</td>
<td>FYI_75</td>
<td>28,757</td>
<td>1</td>
<td>.039</td>
</tr>
<tr>
<td>2</td>
<td>RYI_100</td>
<td>27,992</td>
<td>.973</td>
<td>.065</td>
</tr>
<tr>
<td></td>
<td>OYI_100 (wheat),</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NYI_100 (sunflowers)</td>
<td>27,756</td>
<td>.965</td>
<td>.073</td>
</tr>
<tr>
<td></td>
<td>RFI (wheat), FYI_75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>(sunflowers)</td>
<td>27,111</td>
<td>.943</td>
<td>.094</td>
</tr>
<tr>
<td>5</td>
<td>NYI_100</td>
<td>26,668</td>
<td>.927</td>
<td>.109</td>
</tr>
</tbody>
</table>

*Note: *Achieved certainty equivalent as share of maximum achievable certainty equivalent.

**Conclusions and recommendations**

Following the course of the analysis, the conclusions are threefold.

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\(^4\) Correlation tests between weather parameters and sunflower yields did not yield sufficient values for a decision to design weather-based products for sunflowers as well.

\(^5\) Oblast yield insurance could not be designed for sunflowers due to missing data.
The supply-side analysis provided insight into the institutional framework of the crop insurance system in Kazakhstan. It became clear that the institutional preconditions for establishing a proper system are rather weak and do not support the political objective of providing large and small agricultural producers with equal access to crop insurance. Furthermore, the available insurance products are not preventing the problem of asymmetric information to a satisfying degree. Pilot-testing alternative insurance products could supplement specific state legal actions, which should aim at creating incentives for insurance companies to provide high-quality insurance services to all customers.

The discussion of potential insurance products suggests that innovative products such as area yield and weather index insurance are most appropriate for transition conditions. This conclusion is partly underlined by the results of the employed mathematical programming model. However, conclusions regarding the efficiency of considered insurance instruments should be drawn considering regional specifics.

Further research could test the effects by considering alternative utility functions and risk aversion coefficients on income and utility. Furthermore, study farms in other regions should be analyzed to derive conclusions on a broader scale. Finally, further production activities could be integrated into the programming model to better evaluate the portfolio effect.
References


